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[*May* 22, 1934, *continued*]

A New Electrocardiograph Employing the Cathode Ray Oscillograph as the Recording Device.

By DOUGLAS ROBERTSON, B.M., M.R.C.P.

ABSTRACT.—The advantages of the cathode ray tube as an electrical recording instrument are unique. It has no inherent inertia, so that there is no distortion from this source as there is in every known electro-mechanical recorder. The workings of the cathode ray oscillograph are explained and discussed. Immediate visual observation of the electrocardiogram is obtained by the use of a new fluorescent screen, which is described, and the mechanism of a suitable "time base" circuit for this purpose is explained. Some of the problems associated with the design of an amplifier, distortionless as far as electrocardiography is concerned, are dealt with, including the use of long "time constants" and the employment of a suitable filter circuit. The design of a suitable camera unit (for photographic recording) is discussed. A method of neutralizing interference picked up from alternating current electric light mains is explained and illustrated.

The apparatus consists of four easily portable, and mechanically robust, units. The Recorder Unit, the Amplifier Unit, the H.T. (high tension) Supply Unit, and the Camera Unit.

RÉSUMÉ.—Parmi les instruments d'enregistrement électriques, l'oscillographe cathodique est unique. N'ayant pas d'inertie inhérente il ne produit pas les distortions qui sont inévitables avec tous les systèmes électro-mécaniques connus. L'opération de cet oscillographe est expliquée et discutée. L'observation directe de l'électrocardiogramme est obtenue par l'emploi d'un écran fluorescent spécial, qui est décrit, et l'opération d'un réseau faisant l'office de la "base de temps" est expliquée. Les problèmes qui surgissent dans l'amplification, sans distortion pour l'électrocardiographie, sont discutés, y compris l'emploi d'une longue constante de temps et d'un réseau filtre. L'arrangement d'un appareil photographique pour enregistrer l'image du rayon cathodique est discuté. Une méthode d'éviter les interférences qui peuvent être causées par des courants alternatifs dans le voisinage du malade ou de l'appareil est expliquée et illustrée.

L'appareil se compose de quatre parties, robustes et faciles à transporter: la partie oscillographique, la partie amplificative, la partie pour fournir le courant à haute tension, et la partie photographique.

ZUSAMMENFASSUNG.—Die Kathodenstrahlröhre ist als elektrisches Mess- und Registrierungsinstrument einzig dastehend. Da sie keine Massenträgheit besitzt, ist sie von der Trägheitsdistortion, die in allen elektromechanischen Systemen zu finden ist, vollständig frei. Die Wirkungsweise des Apparates ist erörtert. Durch Anwendung einer neuen Art fluoreszenten Schirmes ist das Elektrokardiogramm sichtbar gemacht, und der Weg zur Herstellung einer hierzu geeigneten "Zeit-Basis" ist besprochen. Distortionsfreie Verstärkung, besonders für elektrokardiographische Zwecke, ist besprochen, einschliesslich der Gebrauch von einer langen Zeitkonstante und ein besonderer Filterstromkreis. Der Aufbau eines Apparates zur photographischen Registrierungen ist besprochen. Eine Methode zur Vermeidung von Interferenz durch Wechselstromleitungen ist erklärt und illustriert.

Die ganze Vorrichtung besteht aus vier soliden Teilen, die leicht transportiert werden können: (1) Der Registrierungsapparat. (2) Der Verstärkungsapparat. (3) Der Hochspannungserzeugungsapparat. (4) Der photographische Apparat.

THE Cathode Ray Oscillograph is an instrument which is only now beginning to be used as an electric recording device to an extent which its intrinsic merits deserve. Braun (1897) was the first to design and use a cathode ray tube. Wehnelt (1905), van der Bijl and Johnson (1920-21), and von Ardenne (1930) have also made important contributions to the production of the cathode ray oscillograph as it is now known. During the last two years the research staff of A. C. Cossor, Ltd., have made additional progress towards the perfection of the cathode ray tube, and the Cossor C.R.O., which is used as the recording device in the present electrocardiograph is generally acknowledged to be the best cathode ray tube at present available. And particularly valuable to the design of this oscillograph have been the contributions of Mr. L. H. Bedford, with whom it has been my privilege and pleasure to work as the co-designer of the present electrocardiograph.

In bio-electric work the first, so far as I am aware, to use the C.R.O., were Gasser and Erlanger (1922), who used the Western Electric tube (designed by Johnson) for the study of nerve action potentials. Rijlant (1931) has studied the electrocardiogram by its means, using the von Ardenne C.R.O.; but it appears, as pointed out by Matthews (1933), that his amplifier system was probably defective, for his curves do not conform to the correct shape.

The electrocardiograph which I am privileged to show you this afternoon possesses a number of original features, which, it is hoped, will make it not only an instrument suited for the exact measurements necessary for research work, but also an instrument whose practical character will appeal to those who require an electrocardiograph as a practical diagnostic instrument. Chief of these features is perhaps the long afterglow fluorescent screen, which enables the electrocardiogram to be examined directly by the patient's bedside without having to wait for the development of photographic material. The instrument is also remarkably robust and reliable; it will stand at least as much bumping about as a portable wireless set, and, as it has no delicately balanced mechanical part, it is not easily damaged and can be relied upon to work in all contingencies. With it the electrocardiogram can easily be made any size that is considered desirable, without distortion, and it can be observed for as long a period as is considered desirable. In spite of this, the apparatus is completely portable, and can be worked off any electric light mains.

The apparatus (*see* figs. 1 and 2) consists essentially of the special cathode ray tube with its accessory controls, and a suitable amplifier with which are grouped certain of the oscillograph circuit arrangements and a "time base" circuit to give a uniform horizontal traverse to the oscillograph spot, for use when the Cardiograph is employed for direct visual observation of the electrocardiogram. In addition, there must be a source of comparatively high voltage—in this case 800 volts—which is necessary for the C.R.O. Although this source of high potential is essential, the amount of current taken from it is very small, and it is arranged that it shall be given by an "eliminator" to work from alternating current electric mains, or by a small rotary converter to work either from a 12 v. accumulator, or, by means of a resistance adapter, from direct current electric mains.

I.—THE CATHODE RAY OSCILLOGRAPH

The mechanism of the cathode ray oscillograph is as follows. The cathode consists of a filament at the top of the arch of which is a small blob of metallic oxide, which has high electron emitting properties when the filament is heated by the passage of a current from a 2-volt accumulator. The electrons emitted from the blob of oxide on the filament are concentrated by means of the negative bias applied to a small cylinder, known as the Wehnelt cylinder, which surrounds the filament. It will be remembered that the electron carries a negative electric charge; it is, in fact, now taken as the unit negative element of electricity. The electrons are sucked at high velocity through a hole in a plate which is charged positively. This

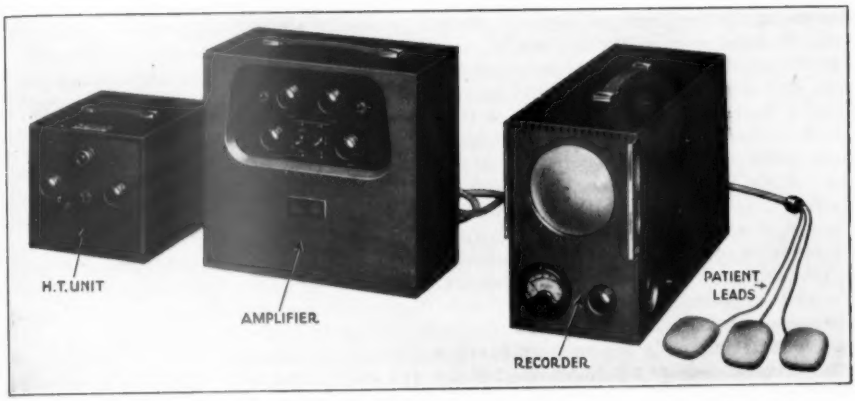
H.T. UNIT
AMPLIFIER
RECORDER
PATIENT LEADS

FIG. 1

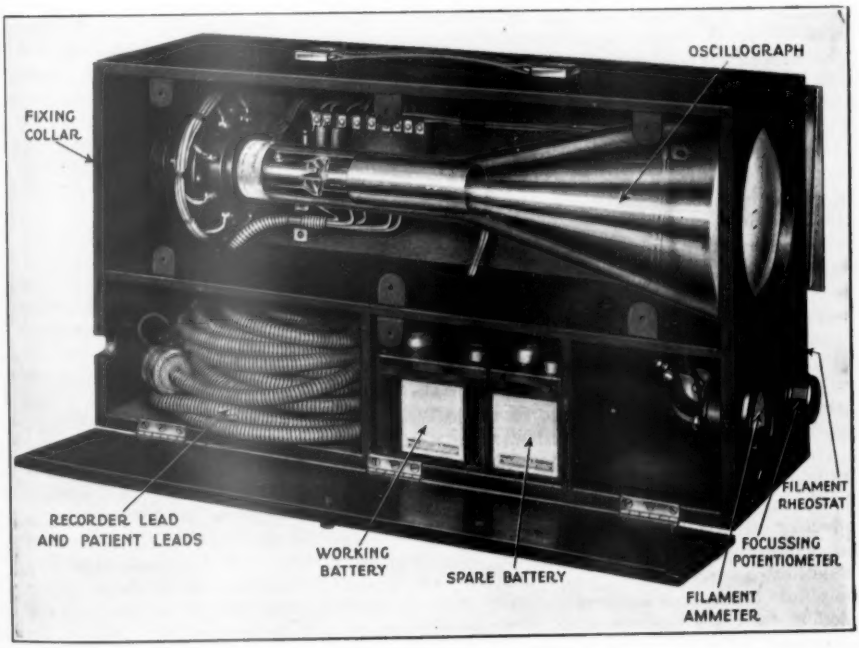
OSCILLOGRAPH
FIXING COLLAR
RECORDER LEAD AND PATIENT LEADS
WORKING BATTERY
SPARE BATTERY
FILAMENT RHEOSTAT
FOCUSSING POTENTIOMETER
FILAMENT AMMETER

FIG. 2

plate is known as the "gun." The electron pencil then passes down the cathode ray tube and finally impinges on a fluorescent screen at the end of the tube, where it appears as the oscillograph "spot." It will be readily appreciated that the cathode ray during its passage down the tube must tend to disperse, since each of its component electrons will repel its neighbour by reason of the negative charge carried by each, and consequently there could be no accurate focus of the spot on the fluorescent screen. It is therefore arranged that the cathode ray tube is filled at low pressure (of the order of 10^{-2} mm. Hg) with a small amount of inert gas, usually helium. During the passage of the cathode ray through this gas a certain amount of ionization of the gas takes place, with the production of some positive ions. These positive ions, being comparatively slow-moving, create a positive charge along the beam, and so, by attracting the electrons, keep the beam concentrated. An exact combination of the gas pressure and the filament current, which determines the rate of production of the electrons, together with the negative bias applied to the Wehnelt cylinder, determine an accurate focus of the spot. In practice, the gas pressure is predetermined by the manufacturers, so that the filament current and bias voltage remain as the two necessary controls for an accurate focus.

In the immediate neighbourhood of the gun are located two pairs of plates, each pair set at a right angle to the other pair. These plates are conventionally known as the *Px* plates affecting the horizontal traverse of the spot, and the *Py* plates affecting the vertical traverse of the spot. If one of a pair of these plates is charged positively relative to the gun, and the other of the pair relatively negatively, the cathode ray is bent towards the more positive plate. The total voltage variation of a plate to allow a complete sweep of the spot across the oscillograph screen varies with the gun voltage. In the case of the Cardiograph arrangement this voltage variation for a complete sweep of the screen is about 160 volts. This gives an indication of the amount of amplification to be arranged for when the tube is to be used for electrocardiography (*see* Section III).

It will be realized that, as the electron has no appreciable mass, there cannot be any distortion in the C.R.O. by reason of inherent inertia, and it must, for this reason alone, be immeasurably superior to any electro-mechanical recorder. Even the "string" of the familiar string galvanometer has considerable mass when compared to the electron, and therefore any quickly occurring component of the electrocardiogram—such, for instance, as a split QRS complex—may not be correctly followed by the string, owing to the inertia present due to its mass, and is distorted. In the case of most portable electrocardiographs the tendency to distortion by reason of inertia of the moving part is considerably greater even than the string galvanometer. In general, a certain mass is inevitable for the sake of robustness, so that the moving part of the galvanometer system is not too easily put out of adjustment by the stresses which must occur in a portable instrument, and there must therefore always be a certain error in them due to this mass. The cathode ray tube possesses none of these disadvantages. It is remarkably robust, and its moving part has no inertia. The C.R.O. does, without exaggeration, really illustrate the "dynamics of a particle," and cannot be compared to any mechanical oscillograph, since it is not the limiting case of a mechanical oscillograph of diminishing inertia. "The mechanical oscillograph gives an instantaneous deflection set by the balance between a deflecting and a restoring elastic force; the electron-jet[1] oscillograph has no restoring forces, and the instantaneous deflection represents simply the transverse distance travelled by an electron under the whole transverse accelerating field or fields in the time allowed by its forward velocity, for travelling the axial distance between entry into the field and impact on the screen" [2].

[1] It is really the extremely rapid movement of the electron, rather than its small mass, which determines the properties of the cathode ray oscillograph; so that the absence of distortion is inherent in the jet principle, rather than in the minute mass of the electron.

There is, however, one distortion which is present in the gas-filled C.R.O. which is known as "origin distortion." Although it is true that the movement of the spot on the fluorescent screen is a linear function of the potential difference between a pair of deflecting plates over nearly the whole of its sweep, nevertheless, as the voltage difference between the plates changes sign—from positive to negative, or vice versa—that is, when the potential difference between them is about 2 to 6 volts, the movement of the spot lags behind the deflecting plate voltage, and there is correspondingly a momentary check to the sweep of an evenly moving spot, corresponding to the "origin" of the cathode ray tube. This origin distortion in the case of the vertical, or *Y*, plates might have been a source of some slight error in the electrocardiogram, but it has been surmounted by a recent invention in which one of the pair of deflecting plates is divided and the new plate so used that the origin comes beyond the confines of the fluorescent screen. This new arrangement can be adapted to the cardiograph circuit, and electrocardiograms produced with it are therefore free from origin distortion.

One further big practical advantage which the cathode ray tube has over all electro-mechanical recorders is that it is reasonably impossible to damage it by an overload voltage. One is therefore free from the bugbear of broken strings, or other such disadvantages. The worst that can happen is that the cathode ray may leave the confines of the fluorescent screen and become temporarily lost to view.

Before leaving the cathode ray oscillograph itself a few words should be said about the fluorescent screen. Up till quite recently the material composing the screen at the end of the tube could not be arranged to give more than a fraction of a second's afterglow, so that no possibility existed for using the C.R.O. to observe visually comparatively slowly occurring electrical phenomena such as the electrocardiogram. At the time (March 1933) when work was begun on the present cardiograph, Messrs. Cossor had just succeeded in producing a C.R.O. possessing a fluorescent screen of zinc phosphate, which gives a red afterglow of about a quarter of a second's duration. This was found to give hardly sufficient time for the eye to appreciate the electrocardiographic curve before it faded. However, during the course of our work a special form of zinc sulphide, possessing a green afterglow of several seconds' duration, has been produced by Dr. Leonard Levy. The research staff of Messrs. Cossor have been able to incorporate this substance in the oscillograph screen, and it has been found to be ideal for the purpose of visual electrocardiography. This material has the added advantage of a brilliant blue immediate response, which is sufficiently actinic to allow good photographic recording. This is the material which is used for the screen of the Cossor "Type G" C.R.O. used in the Cardiograph.

II.—The "Time-base" Circuit

The "time-base" circuit, which gives a uniform horizontal traverse to the spot, is arranged in the following manner. A condenser (C) is charged gradually through a resistance (R). Across the condenser is connected a Neon discharge tube. The curve relating the potential difference between the condenser plates to time is shown in fig. 3, and is in fact given by the expression :—

$$e = E\left(1 - \epsilon^{-\frac{t}{RC}}\right)$$

Where e = this potential difference.
E = the applied E.M.F.
t = the time in seconds.
R = the resistance of the circuit in ohms.
C = capacity of the condenser in farads.

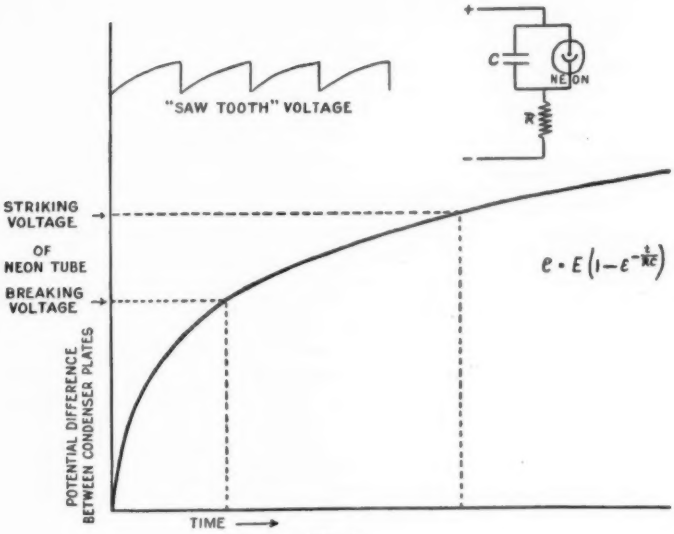
"SAW TOOTH" VOLTAGE
C
NEON
R
STRIKING VOLTAGE OF NEON TUBE
BREAKING VOLTAGE
$e = E\left(1-\epsilon^{-\frac{t}{RC}}\right)$
POTENTIAL DIFFERENCE BETWEEN CONDENSER PLATES
TIME

FIG. 3.

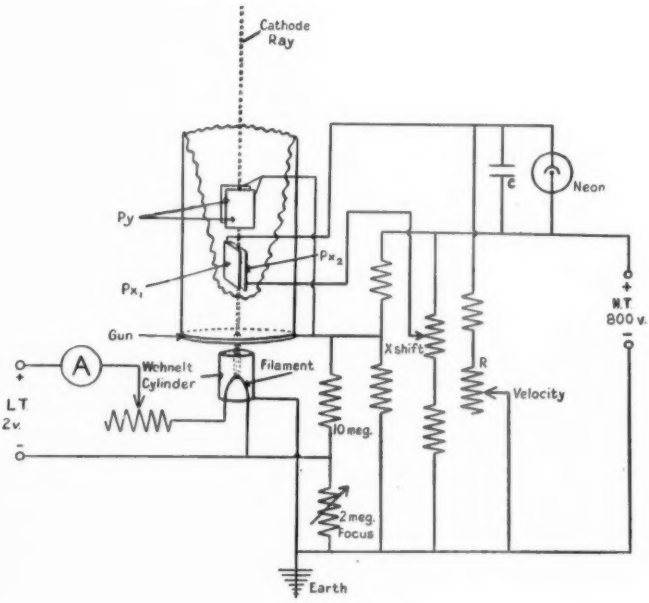
Cathode Ray
C
Neon
Py
Px2
Px1
Gun
M.T 800 v.
A
Wehnelt Cylinder
Filament
X shift
R
Velocity
LT 2v.
10 meg.
2 meg. Focus
Earth

FIG. 4.

When the potential difference between the plates of the condenser reaches a certain value, the Neon discharge tube breaks down, and the condenser discharges itself across it. This potential difference is known as the "striking voltage" of the Neon tube. The condenser stops discharging at the "breaking voltage" of the tube, which is a long way short of zero voltage. We have, therefore, a slow charge, which is not quite linear, but is nearly enough so for visual work, and a quick discharge, giving rise in their consecution to the so-called "saw-tooth" voltage. Each side of the condenser is connected in effect to one of the horizontal, or *Px* plates, so that the oscillograph spot is drawn at a nearly uniform rate horizontally across the screen during the charging of the condenser, and undergoes an extremely rapid, and therefore invisible, flyback when the condenser is discharged across the Neon tube. The value of the resistance R determines the rate at which the condenser is charged, and therefore the speed of the horizontal traverse of the spot. It is an easy matter to arrange a variable resistance, and therefore to give a velocity of traverse to the spot which is directly under control. The diagram (fig. 4) also serves to recapitulate the arrangements for the oscillograph itself; it shows the filament current controls, the Wehnelt cylinder bias potentiometer which is arranged to carry the return space current between gun and filament and so that the spot can be completely de-focused if desired, the "gun" fed from a potentiometer arrangement of resistances, as well as the connexions of the time-base circuit. It also shows the "*X* shift" potentiometer which is used to centre the spot so that its traverse lies evenly across the oscillograph screen. In the diagram the *Y* plates are shown connected to the gun, so that the spot is centralized as far as its vertical deflections are concerned. In the Cardiograph circuit the *Y* plates are connected, the one to a similar potentiometer, forming the "*Y* shift," which is used to centralize the spot in the vertical direction, and the other to the output of the amplifier.

III.—Amplifier

Ideally, for such slowly occurring changes of electrical potential as constitute the electrocardiogram, a direct current coupled amplifier appears necessary, but on the other hand a resistance capacity coupled amplifier presents many advantages provided certain criteria can be fulfilled. Perhaps the most important practical advantage of the R.C.C. amplifier over the D.C. coupled amplifier, as far as electrocardiography is concerned, is that any compensation for skin currents becomes unnecessary, it being only necessary to wait for a short time for the amplifier to settle to a normal iso-electric level between each change of lead.

The actual amount of amplification to be carried out by the amplifier is apparent from the following considerations. It is desirable that there shall be plenty of amplification in hand so that the electrocardiogram can be made any size that is considered necessary, and so that a reasonable falling off in battery voltage will not matter. It has therefore been arranged that one millivolt input shall show, at maximum gain, as about 6 cm. movement of the spot on the screen, which (*see* section on Cathode Ray Oscillograph) is equivalent to about 80 volts potential difference between the deflecting plates. The gain of the amplifier at maximum is therefore about 80,000 times. The "gain control" is arranged so that the amplification can be varied at will, from zero smoothly up to this maximum amount. For visual electrocardiography it will usually be found convenient to work at a gain which gives 2 cm. excursion of the spot on the screen per millivolt, representing twice the standard size of electrocardiogram.

(1).—*The coupling time constants.*—The most important criterion which an

adequate R.C.C. amplifier must satisfy is that the coupling "Time Constants"[1] shall be of such size that there is no appreciable distortion of the slowest component of the electrocardiogram, namely the T wave.

On the other hand, a very long time constant, although minimizing the distortion, will have its disadvantages in determining a very long settling period for the amplifier, particularly after any large change of potential, such as change of lead. The time constant of four seconds has been chosen as determining a fairly short settling period without appreciable distortion. That there is no appreciable distortion is evident in comparing the curves shown ; doubling the time constant (to eight seconds) makes an inappreciable difference to the electrocardiogram (*see* fig. 5).

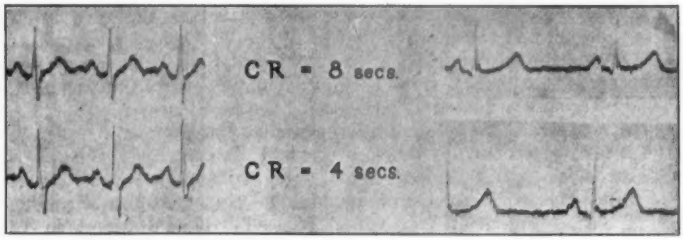

FIG. 5.

(2).—*The filter.* The use of such long time constants for the amplifier presents certain electrical difficulties. The chief of these is that the valves may become what is known as "blocked." In this condition the grid of the valve has become over-saturated with trains of waves at high frequency so that the valve has run into grid current. The large time constant does not allow sufficient time for these unwanted frequencies to leak away to earth through the grid leak, and the "blocking" occurs. It is therefore essential to protect the grids of the valves, particularly the first valve of the amplifier, from high-frequency disturbances. Formerly, this was always done by careful shielding of the amplifier and its associated leads [15], and has never been wholly satisfactory. In electrocardiography far more high-frequency mush will be picked up by the patient himself than by the

[1] The term "Time Constant" requires a few words of explanation for those not versed in electricity. The valves of a resistance capacity coupled amplifier are coupled together through condensers which serve to insulate the grid of the second valve from the high potential D.C. necessary for the supply of the anode of the first valve. And, in order that the grid of the second valve shall be kept at a constant mean potential, a grid leak resistance is connected between it and the filament. This condenser and leak resistance are therefore in series, and obviously the larger the resistance the longer will a given charge take to leak away through the condenser. Alternatively, the larger the condenser the longer the time, for in this case there is a greater quantity of electricity to leak away.

Suppose that the condenser is charged instantaneously to a certain voltage E, which begins immediately to leak away through the resistance R (in ohms). Let C be the capacity of the condenser (in farads). Let the voltage across the condenser at the end of a time t (seconds) be denoted by e.

$$\text{Then} \quad e = E \times \epsilon^{-\frac{t}{RC}}$$

$$\text{When} \quad t = RC$$

$$e = E \times \epsilon^{-1} = E \times 0{\cdot}368$$

The time constant is therefore defined as the time taken for the condenser to lose 63·2% of its initial charge.

In the case of our amplifier, in which there are three such connecting stages, two intervalve and the last between the output valve and the C.R.O., each of time constant 4 seconds, the case is more complicated. Bedford and Puckle (1934) (ref. 17, p. 14) have shown that, at the low frequency end of such an amplifier the approximate time constant of the whole amplifier is given by the expression $T = \frac{t}{n}$, where t is the time constant of each stage and n is the number of stages. In the case of the Cardiograph amplifier t = 4 seconds and n = 3, so that the time constant of the whole amplifier is 1·33 seconds.

apparatus, so that it would be necessary to surround him completely with an earthed metal cage, which is obviously an impracticable procedure. In some bio-electric amplifiers the combination of shielding and comparatively short time constants will keep the valves free from blocking, but obviously this introduces distortion when the amplifier has to deal with comparatively slow electrical changes.

We have therefore used, throughout the whole amplifier, a system of resistance-condenser filters, six stages in all. The diagram (fig. 6) shows two stages of this filter, one in the grid circuit and the other in the anode circuit of the valve. On the left are shown a series of electrocardiograms, all taken at the same sitting and with our first experimental amplifier. This amplifier was fairly carefully shielded, and the curves were taken in a shielded, earthed room, in which was the apparatus,

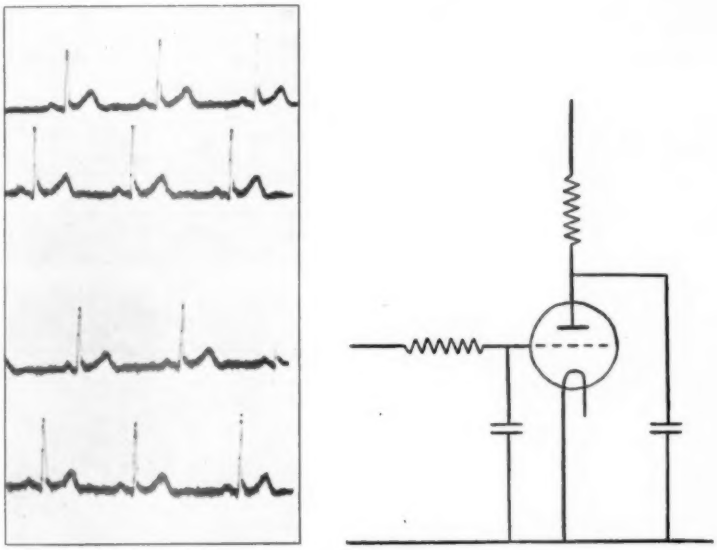

FIG. 6.

patient and observer. The curves show, from above downwards, the effect of removing stages of the filter, as follows. The top curve shows the complete filter in situ. In the next all the filter is removed from both the grid and anode circuits of the first and last valves, leaving the filter of the second valve only in situ. In the third curve the whole filter except that of the anode circuit of the second valve has been removed. The lowest curve shows the whole filter removed. It will be observed how the electrocardiogram becomes successively more and more ragged as the filter is removed. Perhaps the greatest practical advantage of this filter is that no screening of the amplifier is necessary and that screened leads from the patient to the amplifier are unnecessary. In the Cardiograph equipment screened leads are given principally because the tubing used makes them more durable and practical.

(3).—*The frequency characteristic of the amplifier.*—The filter cuts off all higher frequencies arriving at the input end of the amplifier, but its values have been arranged so that there is no cut-off at frequencies which are important in electro-

cardiography. The highest of these is the QRS complex, which occupies about one-tenth of a second (and certainly not less than one-twentieth of a second).

Fig. 7 shows the frequency characteristic of the amplifier, as calculated by Mr. Bedford. It will be seen that it is flat from 0·2 to 30 cycles per second, which includes all those frequencies necessary for undistorted amplification of the electrocardiogram. So that, in summary, as far as the slow-moving parts of the electrocardiogram, as typified by the T wave, are concerned, we are able to produce distortionless amplification by means of long coupling time constants; and the use of such long time constants is made possible by the filter arrangement, which, however, does not cut off too low to distort the quicker moving parts of the electrocardiogram, as typified by the QRS complex.

(4).—*The calibration feature.*—The calibration feature of the amplifier has been designed so that exactly one millivolt is injected, in the form of a short pulse, at the input of the amplifier, when, and as desired, by flicking up and down a key. This calibration device must of its nature be absolutely accurate, and is arranged in the following manner. A resistance network, totalling 2,000 ohms, is put across the

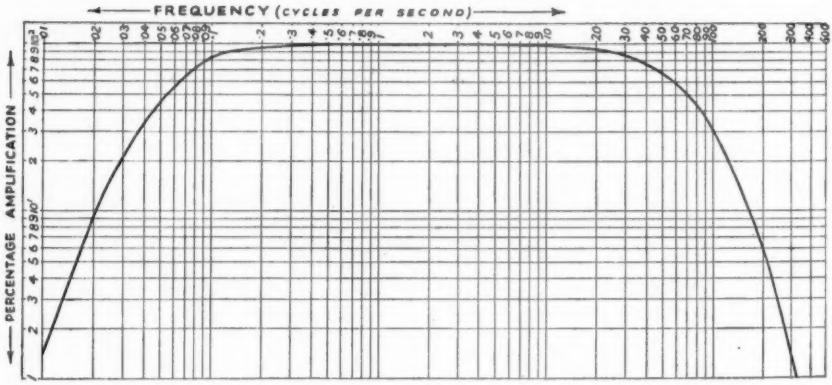

FIG. 7

2·0 volt accumulator which heats the valve filaments. Provided, therefore, that this accumulator is not run down, the current passing through this resistance network must be 1·0 milliampère. Part of the resistance network is a resistance of accurately 1 ohm, through which the passage of 1 milliampère will give 1 millivolt potential difference between its ends. In flicking up and down the calibration key a quick make and break of the key throws this one millivolt for an instant across the input of the amplifier, by short circuiting and immediately open circuiting a part of the resistance network. By arranging that about 10 ohms of the resistance network are included in the key circuit, small variations of resistance of the key are of no account, so that there is no error in the calibration from this source.

One further point should be emphasized in connexion with the amplifier. As pointed out by Groedel (1931) [16], the valve amplifying electrocardiograph gives a truer picture of the electrical changes occurring in the heart muscle than is given by any current recording instrument with a comparatively low resistance (the string of the string galvanometer has usually a resistance of about 3,000 ohms). The reason for this is that the input impedance of the valve is nearly infinite at the frequencies which make up the electrocardiogram, so that the output of the amplifier, if itself

without distortion, is a true picture of the voltage variations occurring across the body and arising from the heart's action. An important practical outcome of this infinitely high input impedance is that the use of non-polarizable electrodes is unnecessary, because, if the resistance is infinitely high, the amount of current which flows is infinitely small, and therefore the amount of polarization which can occur must be infinitely little. The saving in time and the great practical advantage of simple pads soaked in saline, which are all that is necessary, is immediately evident.

IV.—The A.C. Mains "Mush" Neutralizing Device

There is one serious disturbance, which will become increasingly more common in the future with the increase of the "grid" supply of alternating current throughout the country, that is liable to affect the electrocardiogram. This is "pick-up" from alternating current electric mains, usually at 50 cycles, which may occur if the apparatus, or the patient, is near any electric wire connected to such a supply. Obviously it is not difficult to screen the apparatus from this source

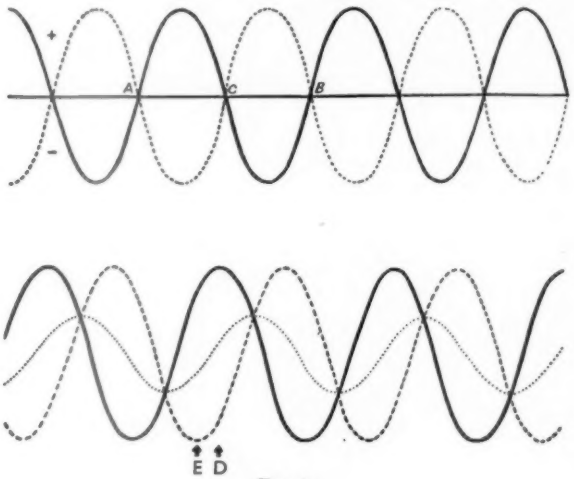

Fig. 8

of interference. On the other hand, it is not easy, and certainly not practical, to screen the patient effectively. Further, if the filter arrangement, described in the previous section, is made to cut off at a frequency below 50 cycles there must inevitably be distortion of the electrocardiogram. Therefore some other arrangement has to be contrived if this source of interference is to be satisfactorily circumvented.

Alternating current electricity is a sine wave of 50 cycles, as represented by the continuous line in the upper diagram of fig. 8. A cycle, which occupies 1/50th of a second, is represented by the curve from A to B. The curve from A to C represents an "alternation." If now we could arrange a sine wave voltage exactly equal and opposite to this interfering voltage, the resultant voltage at any instant of time would be zero, as represented by the straight base line, and the interference would be completely neutralized. It is further necessary that this neutralizing sine wave shall be exactly in anti-phase to the original interfering voltage. If it lags behind, as shown in the lower diagram, by an amount represented by the distance D E, the resultant voltage is no longer zero, but is represented by a sine curve of

the same frequency but smaller in amplitude than the original interfering voltage. It is therefore necessary to give a phase control to the neutralizing voltage, so that its peaks may lie exactly opposite those of the interfering voltage. We have been able to arrange these matters in the "mains eliminator" which is used when the apparatus is worked from A.C. mains, and that it is efficacious is shown in fig. 9. It is very striking to see the way in which considerable mush fades away on manipulating the controls and leaves the clean picture of the electrocardiogram. It should be pointed out that the use of this device does not in any way distort the electrocardiogram, since it is in no sense a filter; for even if a component of the electrocardiogram which happened to be at 50 cycles arrived at the amplifier, it would overbalance the neutralizing voltage by just its true amount, and would still remain undistorted.

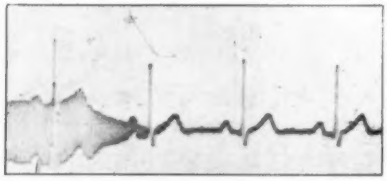

FIG. 9.

V.—PHOTOGRAPHIC RECORDING OF THE CATHODE RAY IMAGE OF THE ELECTROCARDIOGRAM

It is perfectly feasible to focus an ordinary plate camera on the end of the oscillograph tube and to take one traverse of the spot, as it appears for visual observation—opening the shutter at the beginning, and closing it at the end, of the traverse of the spot. But if, as appears desirable, the photographic record of the electrocardiogram is to be accurately calibrated, there are a number of objections to the above practice. Some of these are the following:—

(i) As explained in Section II, the movement of the spot across the screen, although nearly linear in time, is not quite strictly so.

(ii) Owing to the curvature of the end of the oscillograph tube it is difficult to get an accurately focused image of the spot over the whole length of its traverse.

(iii) As the length of this traverse is about 5 in., a considerably longer focus lens would be necessary, and consequently the camera unit would have to be longer and less neat than it is.

(iv) The length of record obtainable by a single sweep of the spot, although adequate for the study of some heart conditions, would not be long enough for a considerable number of others.

(v) It would require a deal of extra apparatus to obtain a reliable time indication in working by this method, whereas this is easily obtained by using moving film, as shown below. An attempt was made in the earlier experiments to rule the end of the oscillograph tube with a scale, and to time the traverse of the spot over this scale with a stop watch, setting the "velocity" control to give an exact speed of traverse. One major objection to this practice is the following. The sensitivity of different oscillograph tubes may vary considerably—by as much as 10 or 15%. So that, assuming a certain tube gives, with a particular Neon discharge tube, a length of X sweep just less than the diameter of the fluorescent screen, it would be possible to time the traverse of the spot satisfactorily with this tube. But if this tube is replaced by one which is more sensitive, giving a greater sweep of the spot for the same voltage variations of its Px deflecting plates, then the length of the X sweep

will exceed the diameter of the fluorescent screen, and it will therefore be impossible to time its traverse with any accuracy.

The camera unit has therefore been designed to work with moving film and with the spot stationary in the horizontal, or *X*, direction, so that the movements of the spot become strictly comparable to the movements of the string in the case of the string galvanometer. The camera is arranged to give an exact 2 : 1 reduction of the size of the movement of the spot, which comes automatically into correct focus on the film. A spy tube is provided and is arranged so that what is apparent to the observer's eye is also recorded on the film. The film used is standard (35 mm.) cinema film or paper (procurable anywhere), which is obtainable in convenient length in the form of the Leica daylight loading capsule, which holds 54 ins. of film, sufficient for a continuous run of just over one minute.[1] Or similar reloadable

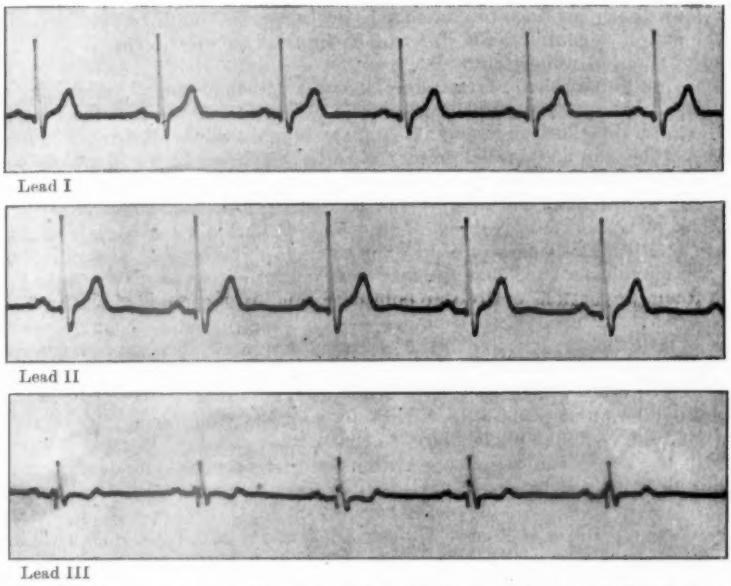

FIG. 10.—A normal electrocardiogram recorded with the apparatus described in the text (1·0 cm. = 1·0 mV., 2·0 cm. = 1·0 sec.).

capsules, to hold film or paper, can be obtained if desired. The film is moved by means of a specially designed clockwork motor, whose governor is set to allow a motion of film of precisely 2·0 cm. per second. The film is wound on to a drum (2 ins. in diameter) inside which is coiled the motor spring. It is calculated that the error introduced by reason of increase of the diameter of this drum carrying successive layers of film is less than 2%. When the film is completely run through it is rewound into its light-tight capsule. The operation of rewinding the film also rewinds the motor spring ready for the next run, and automatically ensures that it is at correct tension. The use of a time marker is dispensed with, and time indications are obtained by means of a comparator, which is found to give a very satisfactory time indication, measurable to 1/100th of a second. The only disadvantage of this procedure is that variation of speed of the record is not possible,

[1] A new camera unit for use with a large roll of paper (about 50 ft.) is in process of design and construction.

but, as the cathode ray oscillograph gives a clearer picture than the string galvanometer, this disadvantage is more apparent than real, and seems to us to be more than off-set by the saving in extra apparatus which a special time marker would involve. It must be realized that any simple time marker such as a vibrating reed, or a method of periodically quenching the oscillograph spot, would give rise to an objectionable form of time marking, as the instrument is a light recording one, as opposed to the shadow recording of the string galvanometer. The electrocardiogram would therefore appear as a piebald black line on a white field in the negative, or vice versa in a print. It would be necessary to have a positive scheme of time marking with an extra source of light. We considered, therefore, that provided the clockwork motor which moves the film is really accurately governed, the comparator method adopted would give a perfectly adequate time marking. That the clockwork motor does move the film uniformly is proved by a slide [demonstrated], which shows a "saw-tooth" voltage of precisely 10 cycles per second, taken at the beginning and at the end of a complete (54 in.) run of film. The mean error is 1·68%, and the speed of running is uniform.

The moving film method of recording does not preclude the simultaneous visual observation of the electrocardiogram, since it is easy to stop the "time base" on one oscillograph (by short-circuiting its *X* plates to gun) while allowing it to function on another tube, run in parallel from the same amplifier unit. For this purpose two sockets are provided at the amplifier unit for connexion to recorder units, and a switch for stopping the time base is arranged to function for one only of these two sockets. The only disadvantage of recording while the time base is working is that there is, at intervals determined by the setting of its control, a small displacement of the curve each time that the discharge occurs across the Neon tube. As it has been found impossible entirely to eliminate this displacement of the spot, it has been arranged that the effect shall be deliberately exaggerated, so that no possibility can exist of its being confused with the electrocardiogram. The spot is arranged to fly right off the picture, and this it does so quickly that it does not register on the film, so that the nett effect is seen as a small interruption of the electrocardiogram. When photographic recording is done without simultaneous visual observation, the time base is best switched off entirely, so that not even this occasional interruption can disturb the electrocardiogram; a switch for this purpose is made integral with the time-base speed control resistance.

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Diaphragmatic Paralysis: A Critical Review of its Use as a Therapeutic Measure in Respiratory Disease

By A. J. CAMPBELL, M.D., D.P.H.

ABSTRACT.—Diaphragmatic paralysis first suggested as a therapeutic measure in lung disease by Steurtz (1911), who did simple phrenicotomy. Felix (1922) showed in 25% of cases this was ineffective owing to the presence of an accessory phrenic, and suggested phrenic exairesis, i.e. complete evulsion of the phrenic nerve. Goetze (1922) suggested radical phrenicotomy, i.e. division of the phrenic and excision of the nerve to the subclavius.

Effects of diaphragmatic paralysis.—The diaphragm rises to the full expiratory position (4-8 cm.). Paradoxical movement (Kienböch's phenomenon) on affected side. Muscle atrophies. Collapse of the lung produced, affecting base and apex also. Lung volume reduced by $\frac{1}{4}$th to $\frac{1}{3}$rd.

Physical signs.—Indrawing of the epigastrium. Thoracic breathing. Litten's sign absent. Less resistance to abdominal palpation on affected side. Diminished resonance at border of sternum and at base. Deficient inspiratory murmur at base.

Radiography.—Paradoxical movement. Bittorf's test.

Indications.—(A) Pulmonary tuberculosis.

I. As the sole therapeutic measure.
   (1) In cases where pneumothorax has failed.
   (2) For relief of symptoms such as: (*a*) hæmoptysis; (*b*) cough; (*c*) tachycardia (*d*) nausea and vomiting; (*e*) pain; (*f*) hiccup.

II. Combined with pneumothorax.
   (*a*) For basal adhesions; (*b*) alternative to bilateral pneumothorax; (*c*) to lengthen interval between refills; (*d*) at conclusion of pneumothorax treatment.

III. Combined with thoracoplasty.

(B) Other diseases.

Unresolved pneumonia, fibrosis of the lung, bronchiectasis, abscess of the lung, hydatid disease.

RÉSUMÉ.—La paralysie phrénique fut recommandée comme agent thérapeutique pour la première fois par Steurtz (1911), qui fit une simple phrénicotomie. Felix (1922) démontra que cette opération était inefficace dans 25% des cas, à cause de la présence d'un phrénique accessoire, et suggéra l'exairèse du phrénique, c'est-à-dire l'avulsion complète du nerf phrénique. Goetze (1922) préconisa la phrénicotomie radicale, c'est-à-dire la section du phrénique et l'excision du nerf jusqu'au subclavius.

Effets de la paralysie du diaphragme.—Le diaphragme monte jusqu'à la position d'expiration complète (4-8 cm.). Mouvement paradoxal du même côté (phénomène de Kienböch). Atrophie du muscle. Collapsus du poumon, portant sur la base ainsi que sur le sommet. Volume du poumon réduit de 1/6 à 1/3.

Signes physiques.—Retirement de l'épigastre. Respiration thoracique. Absence du signe de Litten. Résistance à la palpation de l'abdomen diminuée du côté opéré. Résonance diminuée au bord du sternum et à la base du poumon. Murmure inspiratoire défectif à la base du poumon.

Radiographie.—Mouvement paradoxal. Épreuve de Bittorf.

Indications.—(A) Tuberculose pulmonaire.

I. Comme seul traitement.
   (1) Dans les cas où le pneumothorax a échoué.
   (2) Pour soulager des symptômes tels que: (*a*) l'hémoptysie; (*b*) la toux; (*c*) la tachycardie; (*d*) les nausées et les vomissements; (*e*) la douleur; (*f*) le hoquet.

II. Associée au pneumothorax artificiel.

(*a*) Dans les cas d'adhésions basales; (*b*) comme alternative au pneumothorax bilatéral; (*c*) pour augmenter l'intervalle entre les remplissements du pneumothorax; (*d*) à la conclusion du traitement par le pneumothorax.

III. Associée à la thoracoplastie.

(B) Dans d'autres maladies.

Pneumonie non résolue, fibrose du poumon, bronchectasie, abcès du poumon, hydatides du poumon.

ZUSAMMENFASSUNG.—Die Zwerchfelllähmung wurde zum ersten Mal von Steurtz (1911), der einfache Phrenikotomie durchführte, als therapeutische Massnahme vorgeschlagen. Felix (1922) zeigte dass bei 25% der Fälle diese Operation unwirksam ist, weil accessorische Nerven vorhanden sind, und schlug die phrenische Exairese vor, das ist, die vollständige Abtragung des N. phrenicus. Goetze (1922) schlug die radikale Phrenikotomie vor, das ist, Sektion des N. phrenicus und Ausschnidung des Nervens bis zum Subclavius.

Wirkung der Zwerchfelllähmung.—Das Zwerchfell steigt bis auf die vollständige Exspirationsstellung (4-8 cm.). Paradoxe Bewegung auf der betroffenen Seite (Kienböch'sches Phänomen). Muskelatrophie. Lungenkollaps an der Base sowohl als an der Spitze. Lungenvolumen um 1/6 bis 1/3 vermindert.

Körperliche Zeichen.—Epigastrium eingezogen. Brustatmung. Litten'sches Zeichen fehlt. Verminderter Widerstand gegen Abdominalpalpation auf der betroffenen Seite. Herabgesetzte Resonanz am Sternalrand und an der Lungenbasis. Mangelndes Inspirationsgeräusch an der Lungenbasis.

Radiographie.—Paradoxe Bewegung. Bittorf'scher Versuch.

Indikationen.—(A) Lungentuberkulose.

I. Als einzige therapeutische Massnahme.

(1) Bei Fällen wo der Pneumothorax versage hat.

(2) Zur Beseitigung von Symptomen wie: (*a*) Hämoptyse; (*b*) Husten; (*c*) Tachykardie; (*d*) Übelkeit und Erbrechen; (*e*) Schmerzen; (*f*) Singultus.

II. Mit künstlichem Pneumothorax kombiniert.

(*a*) Bei basalen Verwachsungen; (*b*) in Stelle von bilateralem Pneumothorax; (*c*) um die Zeit zwischen Wiederfüllungen zu verlängern; (*d*) am Ende der Pneumothoraxbehandlung.

III. Mit Thorakoplastie kombiniert.

(B) Andere Krankheiten.

Ungeheilte Pneumonie, Lungenfibrose, Bronchiektasie, Lungenabszess, Echinokokkose.

The subject of diaphragmatic paralysis has become one of considerable interest in clinical medicine of recent years, largely owing to the fact that it has been utilized as a therapeutic measure in certain diseases of the respiratory tract. In this short paper an attempt will be made to review briefly the present state of our knowledge regarding the effects produced by paralysis of the diaphragm, the main indications for its use, and the clinical results which may be expected in those pathological conditions, in which it has been employed.

It was formerly maintained that the diaphragm was mainly responsible for the expansion of the lower lobes (Hultkranz [17], Pasteur [27], etc.); and in fact Pasteur held the view that post-operative collapse of the lung was due to loss of diaphragmatic function. Other workers (Keith [18], Briscoe [8], etc.), have shown, however, that the diaphragm exerts its action on the apex as well as the base of the lung. It has been observed that pulmonary tuberculosis and other asthenic states are often associated with a long narrow chest and a low diaphragm (Wenckebach [32]); in rabbits, after the diaphragm has been paralysed, if an

injection of tubercle bacilli is given, the disease fails to develop in the paralysed side (Carl [12]).

Observations such as these suggest that paralysis of the diaphragm might be of value in cases of pulmonary tuberculosis where a satisfactory collapse cannot be obtained by artificial pneumothorax on account of adhesions between the parietal and visceral layers of the pleura.

In such cases section of the phrenic nerve in the neck was first suggested by Steurtz [30] in 1911, as he believed that the collapse and rest of the diseased lung which resulted would facilitate healing. Schepelmann [29] later in 1913 confirmed this view and stated that paralysis of the diaphragm would also favourably influence apical tuberculosis. Sauerbruch [28] in 1913, without the knowledge of Steurtz's having proposed this operation, published an account of five cases on which he had operated. Up to 1914 he had operated on twenty-six such cases, all of which were the subject of careful radiological study by Walther [31], who found that less than 50% of the cases showed the paradoxical movement, which is characteristic of diaphragmatic paralysis; in other words the operation in a large percentage of cases had not produced the desired result. It was not until after the publication of the anatomical research on the phrenic nerve by Felix [14] in 1922 that this was explained.

The accessory phrenic nerve.—Felix showed that in 25 to 30% of normal individuals there is present an accessory phrenic which is not usually divided by a simple section of the phrenic nerve at the level of the omohyoid muscle, and that after such an operation a return of diaphragmatic movements is generally due to this cause. The accessory fibres arise from the brachial plexus, usually from the fifth or sixth cervical nerves; they may arise as a single bundle or as a series of two or three nerves which run an oblique course downwards, and unite with the main phrenic nerve after crossing the subclavian vein just under the sternoclavicular joint; the union may take place higher than this, near the usual site of phrenicotomy at the level of the omohyoid muscle, or lower, close to the hilus of the lung. These accessory fibres generally run in conjunction with the nerve to the subclavius, leaving that nerve just before it pierces the subclavius muscle. This is the most usual variety of accessory phrenic, but in other cases it may consist of fibres from suprascapular nerve, the vagus, spinal accessory or hypoglossal nerves.

Phrenic evulsion.—In view of these anatomical facts, Felix suggested that the operation should be what he termed phrenic exairesis—or what we in this country now call phrenic evulsion—i.e. complete evulsion of the phrenic nerve, together with the terminal filaments from the diaphragm; this operation not only resects the main trunk, but also interrupts the connexions with the accessory phrenic as well. A complete operation such as this is not always possible, however, and it has been found that by evulsing the first 12 cm. of the phrenic nerve from the level of the omohyoid muscle it is possible in the vast majority of cases to include all the accessory fibres and produce a permanent paralysis of the diaphragm. Matson [23] states that in a series of 300 cases he had never observed return of function if 10 cm. or more are evulsed.

The operation of phrenic evulsion is not altogether devoid of risk; sometimes in the presence of adhesions, traction causes pain—for the operation is practically always performed under local anæsthesia—or it may tear the pleura, or the lung, resulting in a pneumothorax or a pyopneumothorax; or it may result in emphysema or infection of the mediastinum. Another possibility is that in some cases the accessory phrenic comes in front of the subclavian vein and joins the main nerve which comes from behind, thus forming a loop which may cause damage to the vein if traction is continued.

Other complications which may occur are hæmorrhage from the pericardiophrenic artery, pulmonary embolism, and pulmonary œdema. In this connexion

Berry [3] has reviewed the literature and collected 4,697 cases in which this operation has been performed. In 57 of these (1·2%) there were complications directly attributable to the operation; of these 26 (0·5%) were fatal. These sequelæ, therefore, when they do occur, are generally of a serious nature, as 40% of them have ended in death.

Radical phrenicotomy.—It was the object of avoiding those complications associated with traction on the nerve that Goetz [16] devised the operation which he termed radical phrenicotomy; this means a simple division of the phrenic nerve at the level of the omohyoid, along with resection of the nerve to subclavius and any other accessory fibres which may be seen.

Radical phrenicectomy.—Many surgeons instead of simply dividing the nerve prefer to do a phrenicectomy, resecting from 2 to 3 cm. of the phrenic, as well as resecting the nerve to the subclavius.

Morriston Davies [25] states that phrenic evulsion, when the nerve comes out easily is the operation of choice; in all other cases the operation should be a phrenicectomy.

Effects of Diaphragmatic Paralysis

(1) *On the diaphragm.*—When the diaphragm has been paralysed by one of the above methods, the dome of the affected side rises and assumes the expiratory position unless it is prevented by adhesions or thickening of the diaphragmatic pleura or an unusually dense fibrotic lung. This rise is due to the fact that the intra-abdominal pressure is positive + 3 or + 5 cm. of water, while the intrathoracic pressure is negative and may reach − 10 or − 12 cm. of water. The dome continues to rise for several months after the operation as the atrophic changes in the muscle proceed; the maximum height may not be attained for six months or a year or even longer; sometimes there is no immediate rise, and yet when examined several months later the dome may have risen quite appreciably. Matson [23] quotes a case of this sort in which, although there was no initial rise at all, yet at the end of nine months the rise was 8 cm. The height to which the dome rises is generally greater in the right side than the left; on an average 4 to 8 cm. is usual, but rises as high as 13 cm. have been reported.

When observed radiographically the paralysed diaphragm is motionless on quiet breathing. On deep inspiration the so-called paradoxical movement occurs (which was first described by Kienböch [19] in 1898), and this is due to the fact, as we have seen, that the diaphragm is drawn upwards by the negative intrathoracic pressure of inspiration, aided by the positive intra-abdominal pressure and forced downwards on expiration, i.e. the opposite of the normal respiratory movement.

Pathological changes: After section of the phrenic nerve, the diaphragm atrophies and becomes a parchment-like membrane; the muscle-fibres are degenerated and show an increase in fibrous tissue; the affected half of the diaphragm is greyish-pink in colour in contradistinction to the reddish-brown colour of the opposite side (Anderson [2]).

(2) *On the lung.*—Diaphragmatic paralysis produces a decrease in the volume of the lung which affects not only the base, but the apex also unless prevented by pleural adhesions, this fact being well supported by the beneficial effects which result from phrenic evulsion in apical disease. A collapse of the lung occurs which is mainly in proportion to the height to which the dome rises; it is more marked in diseased than in normal lung, and more marked where there is fibrosis than where there are exudative changes.

Reduction in lung volume: Under the most favourable circumstances the reduction of lung volume amounts to 1/6th to 1/3rd (Brunner [10]). By spirometry the capacity of the chest is diminished by 400-800 c.c. (normal total capacity 2,400 c.c.). It is obvious that a diminution in lung volume to this extent is not likely to give rise to dyspnœa per se.

(3) *On the heart.*—There is little effect on the heart as a rule; it may be displaced slightly to the opposite side or slightly upwards in a left-sided case. The electrocardiogram is normal after phrenicectomy.

(4) *On the stomach.*—Gastric symptoms have been occasionally observed after phrenicectomy, but as a rule the consequences are not serious (Cooper [13], Klee [20]); in some cases there is a gaseous distension of the stomach. After phrenicectomy the unaffected dome of the diaphragm displaces the œsophagus laterally during inspiration, and it returns again to its normal position during expiration. It has been observed radiographically that the curve which the œsophagus normally makes after it leaves the diaphragm to enter the stomach may become sharper; patients who have a large left-sided pneumothorax and a slight rise of the left dome of the diaphragm following phrenicectomy do not generally show this increased curvature of the lower end of the œsophagus. When observed after a barium meal the œsophagus empties normally following paralysis of the left dome; there is no evidence that cardiospasm can be produced by phrenicectomy (Ballon [6]). Occasionally nausea and vomiting have been relieved after the operation, especially when these symptoms are due to basal adhesions associated with a left-sided pneumothorax.

(5) *Other effects.*—The benefit which may result is not always in proportion to the height to which the dome rises; sometimes a favourable effect is obtained in cases where the rise is slight; it has been suggested that such cases may be due to interference with the sympathetic fibres which are in association with the phrenic (Bonafé [7]). Felix [14] has shown that there is a strand of sympathetic fibres running within the sheath of the phrenic. Belli [4] has observed that there is vasodilatation of the lung parenchyma after phrenicectomy and Lusena [22] has stated that an increase in venous pressure and stasis follows the operation. The whole question at the moment is rather obscure, and one which merits further investigation.

Physical Signs of Diaphragmatic Paralysis

(1) *Inspection.* One of the most marked clinical signs of diaphragmatic paralysis is indrawing of the epigastrium, and in this the costal arches participate; the breathing tends to be thoracic in type; the ribs run less obliquely, the intercostal spaces are broader; the breast is higher than on the unaffected side. In bilateral paralysis the breathing is entirely thoracic; only when the patient is in the upright position is there a slight attempt at abdominal respiration. Litten's [21] sign is absent; its presence in the normal individual is due to a diaphragmatic contraction at that part of the costophrenic space which lies under the lower border of the lung, where the diaphragm is nearest the chest wall. The apex beat may sometimes be displaced upwards or outwards in a left-sided paralysis.

(2) *Palpation.* On abdominal palpation there is normally some resistance, due to the descent of the diaphragm on inspiration; after phrenicectomy this resistance is less on the affected side (Gerhardt [15]).

(3) *Percussion.* Briscoe [9] has described an area of diminished resonance parallel to the border of the sternum on the affected side; it corresponds to a line parallel to the normal attachment of the pleura and is probably due to retraction of the lung. There is also an area of diminished resonance at the base; it may extend as high as the seventh rib in the scapular line. This area is frequently difficult to define accurately owing to the fact that there is generally superadded an area of impaired note due to underlying pathological condition. On the left side the area of stomach resonance may be raised, and in some cases the splenic dullness also.

(4) *Auscultation.* There is a deficient inspiratory murmur at the base on the paralysed side; but the expiratory murmur is often of equal length and intensity on

the two sides of the chest. The breath sounds may be puerile or bronchovesicular in character. Ægophony is often heard at the lower limit of lung resonance, if a deep breath is taken.

(5) *Radiography.* The most definite sign of diaphragmatic paralysis is paradoxical movement (Kienböch's phenomenon [19]), to which reference has already been made. Bittorf [5] has described a test by which this may be more readily elicited. The patient is directed to close his nose and mouth and try to take a deep breath; the paralysed dome rises and the unparalysed descends. Another test is to ask the patient to sniff, when the same phenomenon occurs. In addition to the above paradoxical movement, there is a slight normal movement imparted to the paralysed side by the pull of the central tendon.

Indications

A. Pulmonary tuberculosis.

I. *As the sole therapeutic measure.*—(1) In all cases where artificial pneumothorax has failed—except in cases of extensive disease where a ten-rib thoracoplasty is the obvious alternative to pneumothorax; (2) for the relief of symptoms such as: (*a*) hæmoptysis, (*b*) cough due to diaphragmatic action, (*c*) tachycardia when due to adhesions in the pericardiophrenic space, (*d*) nausea and vomiting, (*e*) pain due to the drag of diaphragmatic adhesions, (*f*) hiccup.

II. *Combined with artificial pneumothorax.*—(1) Where there are basal adhesions; (2) as an alternative to bilateral pneumothorax; (3) to lengthen the interval between the refills: (4) to diminish the size of the thorax when pneumothorax is being abandoned.

III. *Combined with thoracoplasty.*—As a preliminary to the localized thoracoplasty.

B. Other diseases.

Unresolved pneumonia; fibrosis of the lung; bronchiectasis; abscess of the lung; hydatid disease.

Clinical Results

A. Pulmonary tuberculosis.

I. *As the sole therapeutic measure.*—(1) As we have already seen, diaphragmatic paralysis exercises a beneficial effect not only by producing a partial collapse at the base, but also favourably influences apical lesions as well. Cavities diminish in size and tend to close, unless they have thick and rigid walls (Werner O'Brien [32]). Contrary to what one might anticipate, expectoration is actually easier after phrenicectomy; as with other forms of collapse therapy, the amount of sputum is increased at first and then gradually diminishes, producing coincidentally a lessening of toxæmia and often a fall in temperature. Phrenicectomy is indicated in all cases where pneumothorax has failed, either at the original induction, or has had to be abandoned later on account of adhesions, excepting possibly such cases of extensive disease to which the obvious alternative is a ten-rib thoracoplasty.

(2) Diaphragmatic paralysis is also valuable in the treatment of certain symptoms in pulmonary tuberculosis:—

(*a*) *Hæmoptysis.*—Like other measures used in the treatment of hæmoptysis, it is difficult to assess its value in this direction, as every case in which the hæmorrhage ceases is not necessarily due to the effects of the operation. Several observers have reported satisfactory results, and it seems a logical procedure in those cases of hæmoptysis in which pneumothorax has been unsuccessful and a thoracoplasty is contra-indicated.

(*b*) *Cough.*—Morriston Davies [25] has emphasized its value as a measure for the relief of cough, especially when the cough is of diaphragmatic origin. A diseased focus in the neighbourhood of the diaphragm causes a spasm of the muscle in the same way that a tuberculous focus in a joint causes spasm of the surrounding muscles; this spasmodic contraction acts as a barrier to the propulsive force of the intra-abdominal pressure, which is removed when the diaphragm is paralysed, thus facilitating expectoration.

(*c*) *Tachycardia.*—Tachycardia and cardiac irregularities may be improved if they are due to adhesions in the pericardiophrenic space.

(*d*) *Vomiting.*—In left-sided cases nausea and vomiting are sometimes relieved.

(*e*) *Pain.*—It is valuable for the relief of pain due to the drag of diaphragmatic adhesions.

(*f*) *Hiccup.*—It is valuable for the relief of hiccup when due to the pressure of adhesions or pleural thickening on the phrenic nerve at some part of its course (Sauerbruch [28]).

II. *Combined with artificial pneumothorax.*—In conjunction with artificial pneumothorax it is specially valuable in those cases where adhesions at the base prevent a satisfactory collapse Such adhesions cannot generally be dealt with by cauterization, and diaphragmatic paralysis frequently relieves the symptoms to which they give rise (e.g. diaphragmatic cough, or nausea and vomiting in a left-sided case).

It is useful as an alternative to bilateral pneumothorax. In all cases of artificial pneumothorax it lengthens the interval between the refills, and this may be due to the diminished movement; it has been stated that effusions occur less often, but this fact has not been confirmed.

It helps to diminish the strain on the re-expanding lung at the conclusion of pneumothorax treatment, as has been emphasized by J. Alexander [1] and others.

III. *Combined with thoracoplasty.*—Phrenicectomy is useful in collapsing the base in a localized thoracoplasty. Sauerbruch [28] originally suggested that it should be used to test the opposite lung in cases where thoracoplasty was being considered, but its use in this connexion has now been abandoned by the majority of surgeons. It was said to diminish the risk of aspiration into the lower lobe during thoracoplasty, but this is also doubtful.

B. OTHER DISEASES.

(1) *Unresolved pneumonia and fibrosis of the lung.*—An unresolved pneumonia often, in the course of years, leads to fibrosis of the lung and eventually to bronchiectasis [Morriston Davies (24)]. The rise of the dome, by compensating for the shrinking of the fibrous tissue at the base, tends to prevent this, when phrenicectomy is performed as a prophylactic measure.

(2) *Bronchiectasis.*—In cases of established bronchiectasis, however, the results have been less satisfactory, one reason being that bronchiectatic cavities are generally in the mesial half of the lower lobe where the effect produced by the rising dome is much less marked than on the peripheral part of the lung. Another reason is that phrenicectomy does not always facilitate cough and expectoration; occasionally the opposite effect is produced. Particularly in cases with a large amount of sputum, it so hinders cough and drainage that the secretions are held up in the lung, leading to a fatal pneumonia; in fact the sudden flooding of the opposite lung has produced a rapidly developing asphyxia on more than one occasion.

(3) *Abscess of the lung.*—In abscess of the lung it may assist in closing the walls of the cavity after it has been dealt with surgically.

(4) *Hydatid disease.*—The same is true of hydatid disease; when the cyst has been removed it helps to bring the walls of the cavity in apposition.

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Section for the Study of Disease in Children

President—F. C. PYBUS, M.S.

[*May 25, 1934, continued*]

Osteopetrosis

(*Marble Bones; Albers-Schönberg's Disease; Osteosclerosis Fragilis Generalisata; Congenital Osteosclerosis*)

By R. W. B. ELLIS, M.D.

SINCE Albers-Schönberg's original description, in 1904, of a young man suffering from this rare bone disease, rather less than forty examples of the condition have been reported.

The radiological appearances of the bones are characteristic. Symmetrically arranged areas of greatly increased density are seen involving both the membrane and cartilage bones; the base of the skull, the bodies of the vertebræ, and the long bones are those generally most affected. The carpal bones often appear "ringed" with a dark shadow. The dense, compact bone encroaches on the medullary cavity, which may ultimately become almost entirely obliterated. These areas of sclerosis appear in some instances to be of uniform density throughout, or may show transverse lines of rarefaction. The parts of the skeleton unaffected by the sclerosis also usually show some degree of osteoporosis, and the cortex of the long bones may be considerably reduced in thickness until the sclerosis spreads throughout their length. Brailsford has recently drawn attention to the occurrence of vertical cracks in the lower ends of the phalangeal diaphyses (which were themselves the site of dense sclerosis), in the case of an adolescent girl. Unlike the appearance seen in (melo) rheostosis Léri (in which irregular sclerotic lesions extend to form excrescences on the surface of the bone), the contour of the bone in osteopetrosis is not altered by the sclerosis, although clubbing of the posterior clinoid process and of the ends of the long bones (particularly of the lower ends of the femur and the radius) occurs sufficiently often to be regarded as the rule rather than the exception. That this clubbing is not directly due to the sclerosis is well seen in the two cases reported below, in which the main area of sclerosis occurs in the middle third of the shaft of the long bones and completely outside the area of clubbing. Nor can the clubbing be regarded as secondary enlargement to compensate for the area encroached on, since in these cases the area of encroachment is still relatively small. It may be pointed out here that the site of sclerosis within the bone shows considerable variation in different cases, and although several authors have insisted on its appearance at the *ends* of the long bones, these present cases (which show several characteristic features confirming the diagnosis) prove that this distribution is not essential. It is interesting that the skiagrams published by Ghormley of his two cases, a father and son, also show an identical distribution of the sclerosis in the middle third of the shaft of the phalanges. It appears, therefore, that different family groups (see below) present variations of the condition which are, however, constant within the particular group.

The nature of the areas of increased density observed radiologically has given rise to considerable difference of opinion, which is reflected in the number of names that have been applied to the condition. The early description "Marble Bones" has largely been abandoned, since it was found that, in spite of the increased deposition of calcium the bones were abnormally liable to fracture. Karshner suggested the name osteopetrosis, implying limestone rather than marble, and Pirie that of "chalky bones," since he found that the bones could be drilled and broken as readily as chalk. Dupont, on the other hand, from the autopsy findings in a case originally reported by Péhu, Policard and Dufourt, insists that the sclerosed bone is abnormally hard, with areas of rarefaction interposed. He claims that it is through these lines of rarefaction that fractures occur.

Inheritance.—The condition occurs in either sex, and is frequently familial. As mentioned above, the features of the disease may vary somewhat in different family groups. In a few instances it has been directly inherited from an affected parent, either the mother (Pirie), or the father (Ghormley). It is possible that direct inheritance may prove more frequent than at present suspected if the parents of all patients are examined radiologically, since the father of Ghormley's patient was entirely free from symptoms, and his condition only detected when examined in this way. Consanguinity of the parents has been recorded in several instances, to which may be added the two cases reported here, whose parents were second cousins. Considering the cases of direct inheritance from affected parents, however, it is most unlikely that the condition is inherited as a Mendelian recessive character.

Clinical features.—The disease may be manifest at birth, or symptoms may not appear until later life. In general, the condition is progressive, and the prognosis worst in those patients in whom evidence of sclerosis could be detected in early childhood. Although the clubbing of the long bones has frequently caused the condition to be mistaken for rickets, the bony deformities are seldom such as to cause disability. Multiple fractures are frequent in the later stages of the disease, but generally unite readily without an abnormal formation of callus (Kudrjawtzawa). Delayed eruption of the teeth, defective "chalky" calcification, and dental caries are common.

The most striking symptoms, however, and those for which advice is usually sought, arise from the secondary involvement of the hæmatopoietic and nervous systems. Thus, the progressive sclerosis of the long bones gradually reduces the medullary cavity and bone-marrow to a degree incompatible with normal blood formation. Anæmia of myelophthisic type occurs (Boyd); over-activity of the residual bone-marrow at first results in an increase of reticulocytes and nucleated red cells in the peripheral circulation, and is followed by a true aplastic anæmia as further reduction of the bone-marrow takes place. In attempted compensation, there is enlargement of the liver, spleen, and lymphatic glands throughout the body. The severity of the anæmia has caused a number of these cases to be reported as examples of aplastic anæmia, atypical leukæmia, etc., without the primary nature of the bone changes being recognized, and this makes it almost impossible to estimate at all accurately the number of cases in the literature. Goodall's case of "acute myelocythæmia associated with osteosclerosis and other unusual features occurring in an infant," and Hueck's "zwei Fälle von Leukämie mit eigenthümlichem Blut- resp. Knochenmarksbefund" are probably examples.

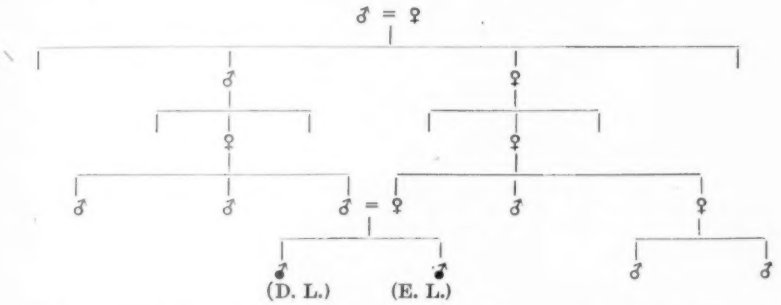
The deposition of dense bone at the base of the skull results in a variety of neurological symptoms, including hydrocephalus and pressure on cranial nerves in their exit from the cranial cavity. Amongst the most common findings are optic atrophy, ocular and facial palsies, and nystagmus. There is frequently clubbing of the posterior clinoid process, and some reduction in size of the sella turcica. It is possible that some of the cases of delayed growth and development have therefore a pituitary origin.

The following two cases are of interest in that they show an early stage of the disease, in which encroachment on the medullary cavity is insufficient to cause anæmia, and an unusual distribution of the sclerosis. They appear to be the third and fourth cases (with the possible exception of Goodall's) to be reported clinically in this country, although skiagrams of other cases have been shown. Wakeley reported a somewhat atypical case (which Brailsford is inclined, on radiological grounds, to regard as more akin to rheostosis Léri) before the Clinical Section of this Society, and Parsons has given brief particulars of a second case. The two cases of "Albers-Schönberg's Disease" reported recently by West are examples of a second and distinct bone-disease described by Albers-Schönberg in 1915 (osteopoikilie or osteopathia condensans disseminata), probably bearing no relation to osteopetrosis.

Case Reports.

Derek L., aged 2 years and 10 months, and Edward L., aged 1 year and 6 months. The patients are brothers.

Family history.—No other children; no miscarriages. The parents are both well and are English. They are second cousins, the relationship being as follows:—



No other relatives known to be affected. Skiagrams of right hand of both parents showed no abnormality.

Derek L. (fig. 1), full term, instrumental delivery, birth weight 8¼ lb. Breast fed for nine months, then a mixed diet, including green vegetables, bone broth, gravy and potatoes. He has had three or four teaspoonfuls of Scott's emulsion regularly since he was 12 months old. He appeared well until 6 months old, when he had a prolonged convulsion at the onset of bronchopneumonia. General health has been moderately good. He sat up at 11 months, stood at 13 months, walked at 18 months; now talks normally for his age and does not seem mentally backward. The eyesight has been thought to be defective since about 6 months of age, and recently the pupils have been constantly dilated.

On examination.—Moderately well-developed boy, height 36 in., weight 30 lb. Circumference of head 20½ in.; intermeatal measurement (over vertex) 13½ in. The face appears rather flattened, and there is moderate frontal and very marked parietal bossing, with a horizontal ridge in the temporo-parietal region comparable to that seen in fragilitas ossium. Below this there is a hollow in the occipital region. The anterior fontanelle is patent. The chest is relatively narrow, and considerable bending of the ribs occurs during respiration. There is no beading or disproportion between the length of limbs and trunk, but there is considerable expansion of the ends of the long bones. Macular atrophy of skin of abdominal wall; no enlargement of lymph-glands, liver, or spleen. All the teeth are defectively calcified and

appear chalky, but have erupted normally. The finger-nails show platyonychia. Pupils dilated, reacting poorly to light. Bilateral weakness of sixth cranial nerve.

Ophthalmic report (Mr. G. G. Penman): "Primary optic atrophy, right and left."

Radiological report (Dr. Bertram Shires): "Skull shows delay in closure of anterior fontanelle and prominent coronal sutures; relative increase in size of cranial

Derek

FIG. 1.

Edward

FIG. 2.

vault. Long bones show greatly expanded ends of diaphyses with cortical thickening, apparently encroaching on medullary cavity in centre of shaft."

Wassermann reaction negative.

Biochemical investigation (26.6.34).—Serum calcium 8·9 mgm.%. Inorganic blood phosphorus 3·39%. Blood phosphatase 12·5 units (normal 10 to 20 units). Blood cholesterol 157 mgm. per 100 c.c. Blood-urea 31 mgm. per 100 c.c.

Blood-count (22.6.34).—R.B.C. 5,113,000 per c.mm.; Hb. 74%; C.I. 0·72; W.B.C. 8,850; Polys. 63%; small lymphos. 23%; large lymphos. 8%; monos. 5%; plasma. 1%.

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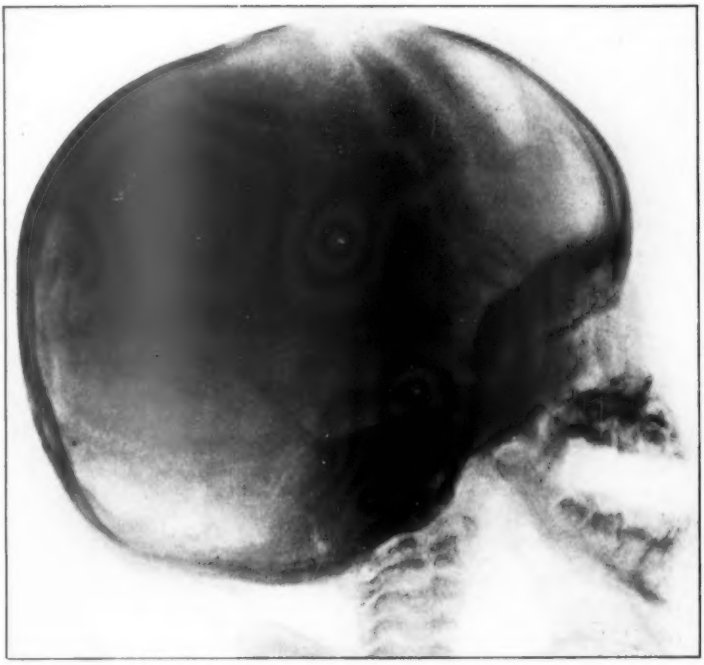
PLATE I



Edward: Skull showing patent fontanelle and dense bone at base.

Derek

Edward

ELLIS: Osteopetrosis (Marble Bones; Albers-Schönberg's Disease; Osteosclerosis Fragilis Generalisata; Congenital Osteosclerosis).

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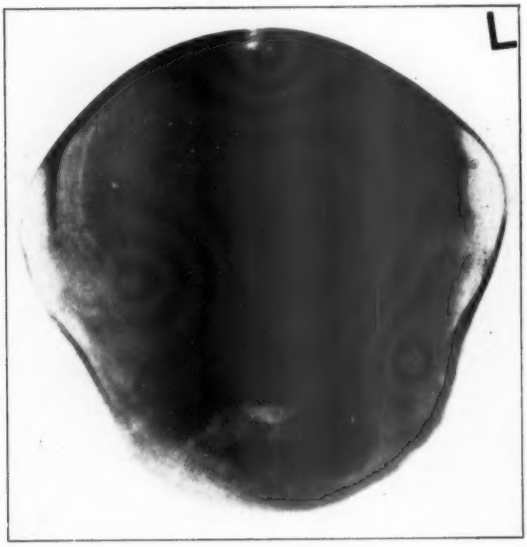
PLATE II



Edward : Skull showing lateral ridging.

Derek : Increased density in middle third of shaft of femora (with obliteration of medullary canal), and in a narrow band at lower end of expanded shaft; stippled and "ringed" appearance of epiphyses.

ELLIS : Osteopetrosis (Marble Bones ; Albers-Schönberg's Disease ; Osteosclerosis Fragilis Generalisata ; Congenital Osteosclerosis).

PLATE III

Edward

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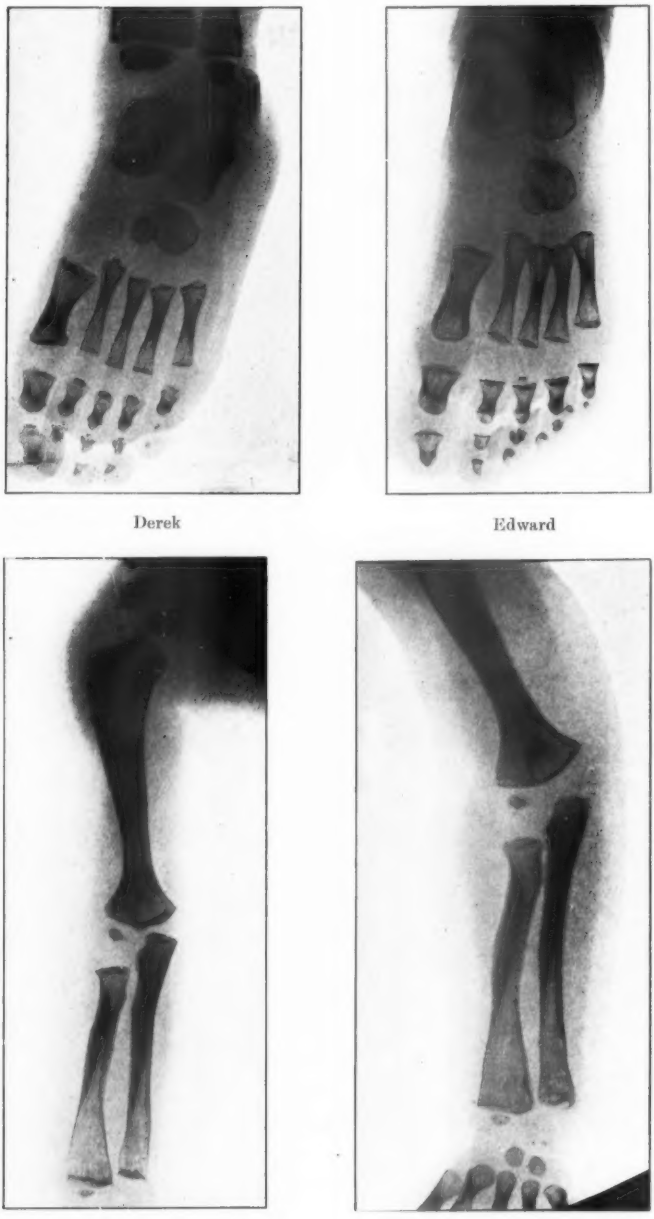
PLATE IV



Derek Edward

Derek Edward

ELLIS: Osteopetrosis (Marble Bones; Albers-Schönberg's Disease; Osteosclerosis Fragilis Generalisata; Congenital Osteosclerosis).

Edward L. (fig. 2). Full term, forceps delivery, birth weight 8½ lb. Breast fed 3 months, then Robinson's patent barley and cow's milk followed by mixed soft solids at 11 months. Scott's emulsion regularly since 11 months old. Started to cut teeth at 5 months, sat up at 13 months, beginning to stand at 17 months. Admitted to hospital at this time on account of tonsillitis and cervical adenitis.

On examination.—Rather feeble infant, making little effort to stand unsupported. Weight 22 lb. Length 27 in. Massive skull, with frontal and parietal bossing, and wide anterior fontanelle. A narrow central bony ridge runs from the anterior fontanelle to the nasion, and temporo-parietal ridging and occipital hollows are present, as in the case of the brother. Circumference of head 20 in.; intermeatal measurement 13 in. Pigeon-breast deformity of chest with some flaring and beading of ribs. Limbs not abnormally short; expansion of ends of long bones, especially at wrists. Heart, lungs and abdomen normal. Bilateral internal strabismus. Deep reflexes present. The pupils are generally dilated, but react to strong light. Bilateral enlargement of cervical glands. Nails show platyonychia. 14 teeth; incisors defectively calcified.

Ophthalmic report (Mr. G. G. Penman).—"Primary optic atrophy, right and left."

Radiological report (Dr. Bertram Shires).—"Skull: enlarged cranial vault, with large fontanelle and wide sutures. Abnormal shape of skull with bossing. No evidence of rickets. Long bones show expanded diaphyses, with thickening of cortex, especially in centre of shafts, and stippling of epiphyses. Appearance almost identical with that of brother."

Biochemical investigations (9.5.34) (Dr. Payne).—Serum calcium 9·97 mgm. %. Inorganic blood phosphorus 4·4 mgm. %. Blood phosphatase 9·6 units (normal 10 to 20 units). Blood-urea 31 mgm. per 100 c.c. Blood cholesterol 170 mgm. per 100 c.c. Wassermann reaction negative.

Blood-count (14.5.34).—R.B.C. 4,200,000 per c.m.m.; Hb. 62%; C.I. 0·73; W.B.C. 14,000. *Differential*: Polys. 50%; small lymphos. 17%; large lymphos. 26%; monos. 2%; eosinos. 3%; Türk 2%.

There was no clinical evidence in either case of thyroid or parathyroid enlargement.

Comment

These two children illustrate several of the classical features of the disease, and show the somewhat peculiar distribution of the sclerosis referred to above. The familial incidence of the condition, and the fact that both children present an almost identical appearance clinically and radiologically (allowing for the slightly more advanced stage in the elder child) emphasize the uniformity within the family group. Thus the peculiar facies and cranial conformation make it obvious that these two children are suffering from the same condition, although they do not correspond closely to the appearance in other family groups. The clubbing of the long bones (without clubbing of the posterior clinoid process), and the neurological symptoms (optic atrophy and bilateral sixth-nerve palsy) are also identical in both cases.

Whilst the occurrence of sclerosis in the middle-third rather than at the ends of the long bones is admittedly atypical of the majority of the reported cases, it undoubtedly represents a familial variation of osteopetrosis and not a distinct disease. Indeed, the elder boy is beginning to show the appearance of a narrow transverse line of increased density at the lower end of the femur, which has been regarded as characteristic of the first stage of the disease. The clubbing of the long bones and the deposition of dense bone at the base of the skull with secondary neurological signs confirm the diagnosis.

Ætiology.—A number of theories of ætiology have been advanced, the majority with little evidence to support them, or general applicability. Thus Robertson has drawn attention to the high vitamin-D content of the diet of his own case, but this factor does not appear to have figured at all prominently in others. From the

familial incidence of the disease, an hereditary factor is clearly operative in at least many of the cases, whilst the nature of the bone changes indicates a disturbance of calcium metabolism. That this disturbance may occasionally extend beyond the osseous system is seen from the case reports of Péhu *et al.* (who recorded the presence of large calculi within the renal pelves), of Schulze, who found deposits of calcium in the tendons, myocardium, etc., and of Alexander, who described calcification of the vessels, tendons, and skin, in a boy aged 11. The few authors who have estimated the serum calcium have obtained normal values, with the exception of Schulze, whose case showed extreme hypercalcæmia and Kopylow and Runowa who recorded a single reading of 13·1 mgm.%. Raised inorganic blood-phosphorus values have also been recorded in one or two instances, Kopylow and Runowa's patient showing 7 mgm.% on two occasions.

The theory for which there appears to be most support is that put forward by Dupont, who regards the primary condition as being parathyroid hyperactivity. Whilst it is now well recognized that parathyroid tumours are liable to result in mobilization of calcium from the bones, with consequent osteoporosis, it has also been claimed that under certain circumstances the local increase in the concentration of calcium may result in a secondary excessive deposition. Dupont based his views on the finding of a parathyroid adenoma in Péhu, Policard, and Dufourt's case at autopsy, and he also drew particular attention to the areas of rarefaction found within the sclerosed bone. These he regarded as the primary result of parathyroid hyperactivity.

Since the publication of Dupont's thesis, certain experimental observations have been made which are at least consistent with a parathyroid ætiology. Pugsley found that in rats the daily injection of parathyroid hormone at first resulted in an increased calcium excretion lasting approximately four days, which was subsequently followed by a normal or subnormal excretion. This acquired resistance to experimental hyperparathyroidism was explained by Selye as due to a proliferation of osteoblasts, which resulted in a condition closely resembling marble bones if the administration of parathyroid hormone was continued. In a recent paper, these two authors have shown that the osteoclastic reaction (osteitis fibrosa) changed over to an osteoblastic one (marble-bone formation) at the same time as the increased calcium excretion and hypercalcæmia returned to normal levels.

In the two cases reported here, the effect of daily injections of parathyroid hormone on the serum calcium and inorganic blood phosphorus was investigated. It was thought that if calcium could be mobilized from the bones by this means, it might be possible to reduce to some extent the degree of the osteopetrosis. For this purpose an initial dose of 5 units of parathormone, followed by daily doses of 10 units, were given subcutaneously in each instance. The effect on the serum calcium and inorganic blood phosphorus is shown in Charts I and II.

The blood phosphatase values (normal 10 to 20 units) were as follows :—

Edward.				Derek.			
Date			Phosphatase (units)	Date			Phosphatase (units)
9.5.34	...	...	9·6	26.6.34	...	...	12·5
12.6.34	...	...	12·7	13.7.34	...	...	11·3
20.6.34	...	...	10·6	23.7.34	...	...	10·9
26.6.34	...	...	14·2	31.7.34	...	...	10·6
23.7.34	...	...	11·8	7.8.34	...	...	8·6
31.7.34	...	...	9·8				
7.8.34	...	...	8·6				
16.8.34	...	...	12·0				

The above figures show the somewhat surprising result that the phosphatase remained within normal limits during the injection of parathormone, although there were considerable variations in the serum calcium values.

From Charts I and II it is seen that in each case there was an immediate rise in serum calcium during parathormone injection, which reached a maximum in ten

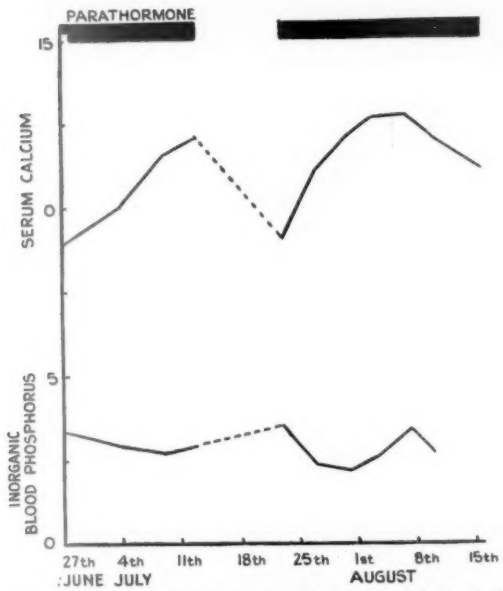


CHART I.—Effect of parathormone administration on inorganic blood-phosphorus and serum calcium (Derek).

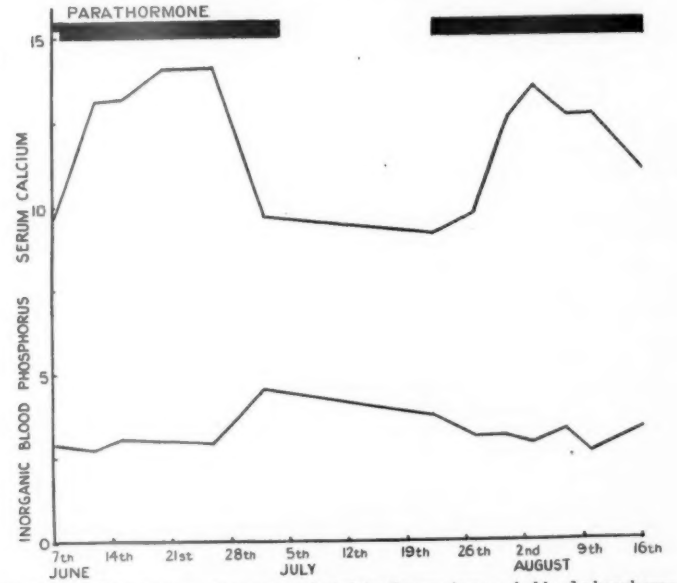


CHART II.—Effect of parathormone administration on inorganic blood-phosphorus and serum calcium (Edward).

to nineteen days, and was followed by a rapid fall, although the dosage of parathormone was kept constant. (This general form of curve corresponds with that described by Pugsley and Selye in adult rats, although the maximum rise, with a larger dose of parathormone, was reached in their experiments in a shorter period.) Although Hunter and Aub have shown that increased calcium excretion following parathyroid hormone injection is not necessarily associated with a corresponding rise in serum calcium, it was assumed from the experimental work referred to above that the fall in serum calcium in these children would be associated with a diminished calcium excretion. Parathormone administration was therefore discontinued when the serum calcium fell, since continuance beyond this point might be expected to result in increased deposition. The same effect was, however, obtained a second time in the case of Edward after a period of eighteen days, and in Derek (in whom owing to contagion the original dosage had been discontinued before the spontaneous fall in serum calcium had occurred) after a period of ten days. It appears, therefore, to judge from the serum calcium, that an acquired immunity to the injection of parathormone is produced, which is lost within a period of eighteen days if the injections are discontinued. The blood phosphorus (which was rather low at the beginning of the experiments) showed a tendency to fall as the calcium rose, and to rise as the latter fell.

It seems probable that these curves are to be regarded as a normal response to prolonged parathormone injection, since acquired immunity of this type has been described in animals.

(A control investigation at present being carried out on a mentally defective child of 1 year 11 months, with no evidence of rickets, gives the following figures:—

Date	Serum calcium (mgm. %)	Inorganic blood phosphorus (mgm. %)	Plasma phosphatase (units)
11.9.34	8·3	3·5	9·1
18.9.34	9·4	2·9	7·8
21.9.34	10·4	3·0	5·8
24.9.34	11·3	2·5	6·2
28.9.34	9·8	3·2	8·4
2.10.34	9·86	3·25	7·2
3.10.34	Parathormone stopped.		

The first estimations (11.9.34) was carried out before parathormone administration was started; it will be seen that the serum calcium was at the lower limit of normal, so that the level subsequently reached represents a considerable rise. Five units of parathormone were injected on 11.9.34, and ten units on each day following throughout the experiment.).

It is somewhat difficult to reconcile the osteopetrosis charts with an existing condition of parathyroid hyperactivity, since if the osteopetrosis were due to the patients being in an "osteoblastic" stage of hyperparathyroidism (i.e. when the activity of the parathyroids was causing deposition rather than mobilization of calcium), it would seem most probable that parathormone injection would tend to cause further deposition immediately rather than an initial *rise* in serum calcium. However, it is quite possible that a condition of hyperparathyroidism may be intermittent rather than continuously operative. This is seen in conditions of hyperinsulinism and hyperthyroidism, and appears likely in view of the alternation of transverse bands of dense sclerosis with lines of rarefaction at the ends of the long bones in many of the advanced cases of osteopetrosis, suggesting periods of varying activity. If, therefore, the patients were in a period of remission when the investigations were carried out, a normal response to parathyroid injection might be expected.

At present the most one can say is that the balance of evidence appears definitely in favour of a parathyroid origin of the disease.

I wish to thank Drs. Hutchison, Cockayne, and Donald Paterson for permission to report these cases, and Drs. Shires and Payne for the radiological and biochemical investigations respectively.

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Section of Dermatology

President—HENRY MACCORMAC, C.B.E., M.D.

[*June* 21, 1934]

Prurigo Nodularis.—J. E. M. WIGLEY, M.B., and GORDON HEGGS, M.D.

A woman, aged 54, had for seven years suffered from an intensely irritable eruption. It had a sudden onset, which she thought was precipitated by overwork. It first appeared on the limbs, then spread over most of the trunk, but did not appear on the face till about three months ago. The irritation is so severe as to interfere seriously with sleep, but otherwise the general health is normal. There is no history of asthma in the family, but a daughter is subject to urticaria.

Condition on examination.—Patient is a healthy-looking woman, who presents a generalized eruption, bearing much evidence of scratching. There is some œdema of the eyelids and eczematous dermatitis of the upper parts of the face and sides of the neck. The eruption elsewhere presents a mixture of lesions, chiefly definitely palpable reddish-brown nodules, about the size of a split pea. On the arms are a number of plane papules, in places coalescing to form areas very suggestive of lichen planus hypertrophicus, and a number of scabbed and crusted lesions. The nodular element of the eruption is more profuse on the limbs than on the trunk. There is slight palpable enlargement of the lymph-glands of the groins, but glands are not palpable elsewhere. There are no lesions in the mouth.

Systematic physical examination shows no abnormality of the other systems.

Urea concentration test Lævulose tolerance test Blood urea Cerebrospinal fluid Blood-sugar	All within normal limits.

Blood-count.—R.B.C. 5,200,000; Hb. 84%; C.I. 0·8; W.B.C. 8·700. Polys. 58%; eosinos. 16·5%; large hyals. 7%; lymphos. 18·5%.

Report of biopsy (Dr. I. Muende).—"There is marked acanthosis with the production of very elongated interpapillary processes. The cells of the stratum malpighii show pronounced intercellular œdema. The stratum granulosum is absent, and the corneal layer replaced by parakeratotic cells. The papillæ are very elongated and narrow, the blood-vessels and lymph spaces dilated, and the papillary body is infiltrated with small round cells.

"Chronic eczematization with the development of prurigo nodules."

We think this case belongs to the group of prurigo nodularis, but it is interesting to note the resemblance of many of the lesions to those of lichen planus, as well as the eczematization of the face.

Treatment by means of high colonic lavage, and large doses of alkalies has given some benefit.

Discussion.—Dr. I. MUENDE said that the histology showed the typical appearances of a hypertrophic prurigo nodule. There were none of the characteristic features usually associated with the histology of hypertrophic lichen planus.

Dr. A. M. H. GRAY said that this was one of those cases which made care in the use of nomenclature necessary. In what could be described as typical prurigo nodularis the lesions were well defined, thickened, and quite dry, and were scattered chiefly on the extensor aspects of the limbs, but might show a fairly extensive distribution. It was the type of case which Pautrier had differentiated from true lichen planus and to which the name lichen obtusus corneus had been applied. He thought, however, that in some cases reported as the latter the condition was really lichen planus.

The case now shown seemed to differ from typical prurigo nodularis, as there was so much eczematization—a distinctly unusual feature. This case, he thought, was an instance of what the French called prurigo with large nodules, a very apt name, and one which prevented confusion with various forms of lichen planus. From the clinical standpoint he agreed that this was prurigo, and not lichen planus.

Dr. F. PARKES WEBER said he thought that the considerable degree of blood-eosinophilia pointed to this case being one of allergic origin; that, he thought, would be generally admitted. But he would like to know whether any members had met with this degree of blood-eosinophilia in a case which was undoubtedly one of ordinary lichen planus. There might of course be an allergic condition complicating ordinary lichen planus.

Dr. HALDIN-DAVIS asked whether Dr. Gray did not think the time had arrived when the term lichen corneus obtusus could be dropped. [Dr. Gray: Yes.] Many cases had been described as such which usually consisted of small pyramids of inflammation, usually on the calves, sometimes on the extensor surface of the arms. These lesions were always rough to to the touch, a feature which was characteristic of them. He thought the term "lichen" should be dropped, because dermatologists were now agreed that these conditions had nothing to do with the clearly defined eruption that was recognized under the name "lichen planus."

From the clinical point of view these patches of nodular prurigo were quite insusceptible to treatment by X-rays, whereas on the ordinary lesions of lichen planus X-rays had a very good effect. The only treatment for nodular prurigo seemed to be protection from the air and from friction. If the involved legs were covered with Unna's paste bandage the patient was more comfortable, and the lesions tended to disappear, though whether they vanished finally was doubtful.

Dr. MUENDE (answering Dr. Parkes Weber) said that although he had not had a case with excessive eosinophilia, he was aware that cases had been recorded with eosinophilia up to about 25%.

Multiple Hæmangiomata associated with Changes in the Central Nervous System. Case for Diagnosis.—J. E. M. WIGLEY, M.B., and G. C. PETHER, M.D.

W. U., male, aged 40.

History.—Rather indefinite. The patient is of poor mentality, but it appears that soon after the War he noticed spots appearing in the skin. These have persisted and have gradually increased in number. No other member of the family seems to have been affected in this way.

Condition on examination.—On the skin and mucous membrane of the lips are numerous hæmangiomata, some being raised and others flush with the surface, suggesting purpura. The raised lesions are on the penis, the others chiefly round the lower part of the trunk and upper thighs.

Central nervous system: Pupils unequal, the left being the larger, and reacting sluggishly to light: The irides appear to be healthy. External ocular movements full. Fundi oculi normal. Tongue slightly tremulous, as also are the hands. Sensation in arms appears to be normal; power also normal, but tendon-jerks brisk. All abdominal reflexes weak.

Lower limbs moderately spastic; knee-jerks very brisk; clonus bilateral. Ankle-jerks normal; no ankle clonus. Right and left extensor plantar response. Sensation in legs normal. The patient is unsteady on his feet, which are flat.

On a previous admission to hospital, October 1933, investigations of the blood and cerebrospinal fluid had shown no abnormality other than a protein of 0·07 in the latter. In that month many septic teeth were extracted.

Readmitted 8.5.34. A blood-count, 14.5.34, showed: R.B.C. 5,310,000; Hb. 94%; C.I. 0·8; W.B.C. 27,550. *Differential*: Polys. 73%; lymphos. 12%; eosinos. 4%; hyalines 11%; platelets 230,000.

The patient is up all day and is afebrile.

A microscopical examination of a section of skin shows fibrosis of dermis, cystic dilatation of a few lymphatics in the corium, a few small foci of slight lymphocytic infiltration, and areas of slight excess of pigmentation in the malpighian layer.

It is thought likely that lesions of a corresponding type have been responsible for the changes in the nervous system.

Dr. PARKES WEBER said that one or two cases like this had been described under the heading "hæmangiomatosis miliaris." If it was desired to draw attention to that feature of the case he would prefer the term "miliary telangiectasia," because, obviously, the minute lesions in question were not real angiomata, but telangiectases—an important distinction, particularly in regard to the question of brain involvement. A part of this telangiectatic condition was comparatively common, namely, the part affecting the scrotum and penis. As a rule, however, men who had only the scrotum and penis affected did not visit doctors, since the patients did not trace any particular disability to the condition. Often there was a little keratosis over the telangiectatic lesions of the scrotum and penis, and such cases might be referred to as cases of angiokeratomatosis of scrotum and penis. He (the speaker) suggested that, for various reasons, the condition of the nervous system in the present case was independent of the skin condition.

There never seemed to be any obvious family tendency to this kind of cutaneous miliary telangiectasia—a condition, which, however, was very rare. It was distinct from the Osler type (often familial) of telangiectasia.

Rat-bite Fever.—Sir ALDO CASTELLANI, K.C.M.G.(Hon.), M.D.

This patient was bitten on the right thumb by a rat in August 1933. The actual bite healed in two or three days. Twelve days later, however, the wound reopened, and the patient had fever, which began with a rigor; the fever lasted three days and then her temperature became normal. During the attack a rash appeared. There have been about fifteen attacks in all, each attack lasting two or three days. The apyrexial period varies in length; sometimes it is of two or three days' duration, sometimes three or four weeks. The rash assumes different aspects; sometimes it is erythematous, at other times it is papular and even nodular. Sometimes the patient shows a diffuse erythematous rash on the face, arms and legs. The subcutaneous tissue may become œdematous. There is no pruritus and practically no pain.

The patient has been treated with various organic preparations of arsenic, chiefly salvarsan and neosalvarsan. When she was brought to me by her doctor the rash was nodular, and it looked like erythema nodosum. I suggested to the practitioner that he should stop giving arsenical preparations and substitute for them bismuth. The patient has had only a few injections of bismuth, and there is no doubt that already she is much better, as the rash has practically disappeared.

Tinea Imbricata.—Sir ALDO CASTELLANI, K.C.M.G.(Hon.), M.D.

This case has been shown on two previous ocassions.[1] The patient contracted the disease eighteen years ago in the tropics, and no treatment of any kind ever had any distinct beneficial effect. Two years ago the eruption involved practically the whole body. Treatment with fuchsin-acetone-resorcinol paint was then begun.

[1] *Proceedings*, 1933, xxvi, 1558 (Sect. Derm., 80); *ibid.*, 121 (Sect. Derm., 1).

To-day the whole body is clear of the eruption, except the right arm and shoulder and the neck, which have never been treated.

I have been asked by several members for the formula of my red paint. It is as follows :—

Saturated alcoholic solution of basic fuchsin 10 c.c.
5% aqueous carbolic acid solution 100 c.c.
Filter, and add boric acid 1 gramme.
After two hours add 5 c.c. acetone; two hours later add resorcin 10 grammes.

The paint to be kept in a dark-coloured bottle, with a glass stopper.

I cannot say exactly why this paint is efficient, but I carried out many experiments with it in New Orleans several years ago, and I concluded that its efficacy depended chiefly on its being prepared according to the directions just mentioned. Certain chemists, apparently, do not know how to make it properly, and a brown, almost black, preparation then results. If prepared according to the instructions it is quite clear, and remains active for many months.

Boeck's Disease (Sarcoid).—ROBERT KLABER, M.D.

This patient, aged 52, has been doing missionary work in Marseilles since 1908. She has not been abroad elsewhere and has not, to her knowledge, had any contact with lepers. Her health, she states, has been delicate since she had appendicitis twenty-seven years ago.

History of present condition.—Twenty-five years ago (1907) she first noticed pain in her left ring-finger whilst playing the mandolin. This gradually became more severe and constant and was later followed by diffuse swelling of this finger. Ten years ago (1924) the first lesion appeared on her left cheek as a small red area. Seven years ago (1927) she had a chronic cough. Her chest was X-rayed and her sputum examined but she was not told whether or not there was any evidence of tuberculosis.

Condition on examination.—Right cheek: Shows simple arborescent telangiectasis. Nose: On the middle of the left side is a slightly raised red plaque, a little more than a square centimetre in area. On glass pressure this shows a number of small confluent grey translucent nodules. Left cheek: The malar area is cyanotic and also shows diffuse telangiectasis. The lower posterior margins of this area are the site of circinate and annular lesions. These lesions have reddened centres and flat, shiny, scaly brown margins. On glass pressure a ring of grey translucent infiltration may be recognized. There are several similar outlying lesions behind. A few small raised nodules showing similar infiltration under the diascope are present just below the left nostril. Left forearm: The extensor aspect shows a few scattered flat lupoid macules but without any palpable infiltration or scarring. The left annularis finger shows diffuse tapering swelling. There are several very small nodules on both sides, underlying, a light purple discoloration. The nail is atrophic and there is a soft cystic swelling suggesting a "ganglion" over the front of the head of the proximal phalanx. The left thumb also shows some discoloration of the nail fold, beneath which minute nodules may be recognized by glass pressure. This nail is discoloured. Right ring-finger: Shows similar changes. Other fingers of both hands appear to be normal. Toes: Show at the distal ends of their dorsal surface, extending on to the pulp, diffuse irregular cyanosis with similar minute nodules to those seen in the fingers.

Skiagrams of hands and feet show several characteristic rarefied areas which are most marked in the left little finger and thumb.

Dr. Yealland, who kindly examined the extremities, could discover no objective sensory disturbance.

Glands: There are chains of moderately enlarged glands in both posterior triangles of the neck. There is a single, much enlarged gland in each axilla and there are a few slightly enlarged glands in both groins. All are firm, smooth and fairly discrete. Abdomen: Liver, spleen and lymph-glands not palpable. Chest: Dr. Bertram Jones reports that there are no active signs of tuberculosis but possibly healed foci at both apices. A single sputum examination has shown no tubercle bacilli. Skiagrams show infiltration and some increased opacity at the right base with enlargement of hilum glands, particularly on the right side.

Wassermann reaction: negative. Mantoux reactions: negative.

Biopsy.—Two sections cut from one of the small papules below the left nostril and another from a macule on the forearm, both show the same essential histology. The epithelium is within normal limits. The corium shows scattered throughout all its layers several confluent, compact, well-defined masses of epithelioid cells, with lymphocytes confined to their borders. There is a little diffuse degeneration but no frank necrosis. Several of the masses, however, contain many giant-cells indistinguishable from those found in tuberculosis.

Ziehl-Neelsen: Serial sections, lightly decolourized, have been examined but no acid-fast bacilli have been discovered.

Discussion.—Dr. I. MUENDE said he had examined both the sections which Dr. Klaber had made, and though he agreed that one of them showed the typical histology of sarcoid; the other, he considered, was true lupus vulgaris. It was, of course, unorthodox to consider that both could exist in the same patient, but the lesion taken from the arm had the typical appearance of lupus vulgaris, as not only around, but also between, the zones of epithelioid cells there was a dense, small, round-celled infiltration. In the other section there were circumscribed masses of epithelioid cells, with no cellular infiltration. Kyrle was of the opinion that even sarcoid was due to the presence of the tubercle bacillus in the cell-nests, so that it was conceivable that the two conditions might on occasion be co-existent.

Dr. J. M. H. MACLEOD did not think it was very wise to label this case sarcoid of Boeck, though he agreed with Dr. Muende that one of the sections showed sarcoid. He considered that it came into the category of lupus pernio.

Dr. A. M. H. GRAY said that in former days this condition would have been labelled lupus pernio, which belonged to the sarcoid group. To give a group name, such as Schaumann did, was all to the good, but whether his name was the best was a matter for discussion. The nodules on the forearm of this patient were very interesting. He had seen such nodules before, but it was very unusual to see them unassociated with a surrounding inflammatory reaction. He believed that one could readily distinguish between the nodules of lupus vulgaris and those of lupus pernio or sarcoid, by means of the match test. The lupus vulgaris nodule was soft and the match sank easily into it; the pernio lesion, on the other hand, was hard, and it was difficult to sink a match into it.

With regard to Dr. Muende's remarks, Schaumann had pointed out that though it was unusual to see a round-celled infiltration in lymphogranulomatosis benigna, such did occasionally occur, and so this could not be used as a means of distinction.

Dr. KLABER (in reply) said he thought most dermatologists would agree that lupus pernio, Boeck's sarcoid, and Schaumann's benign lymphogranulomatosis represented different aspects of the same disease. As to which term should be employed, the last-named was already in use on the Continent as a synonym for Hodgkin's disease, and lymphogranuloma inguinale was now the recognized label for the sixth or seventh venereal disease. There were already a sufficient number of conditions described as lymphogranuloma without adding to their number. Boeck's description antedated that of Schaumann by a long time, and though the term "sarcoid" might well be dropped as soon as possible, Boeck's name should for the present continue to be associated with this disease. [Dr. A. M. H. GRAY: Lupus pernio antedated Boeck's sarcoid.] But that only referred to a small part of the disease.

Vitiligo with associated Alopecia Areata.—ROBERT KLABER, M.D.

This man, aged 39, states that his complexion is naturally rather highly pigmented, but he noticed during his last summer holiday, which was only of one week's duration, a slight increase in pigmentation which has persisted since.

Four months ago he first observed the appearance of white roughly circular areas on the chin, which gradually increased in size, and several coalesced. Since then a similar area has appeared on his right cheek and a few others on his neck.

For some weeks the hair has been falling from most of these areas on the chin, until now most of them are completely hairless. The skin is quite smooth and neither infiltrated nor atrophic.

The hair has also fallen from large diffuse areas on both legs but not elsewhere. There is no vitiligo elsewhere. The hair shows the ordinary type of premature streaky senile whitening, but there is a small white area on the left occiput which suggests an early patch of alopecia.

Past history.—In 1915 he had attacks of dysentery and enteric fever, in the Near East. There has been no serious illness since. His general health is unaffected. The Wassermann reaction is negative.

For the last three weeks he has used bergamot oil locally, and has had general carbon-arc baths. There is a little new growth of hair and erythema, but as yet no pigmentary alteration.

Recurrent Ulceration of the Mouth and Vulva associated with Necrotic Nodular Lesions of the Skin.—ELIZABETH HUNT, M.D.

The patient, a married woman, aged 43, with six healthy children, gave a four years' history of painful ulcers on the vulva and in the mouth, together with acutely tender spots on the legs, occasionally on the arms and hands, more rarely on the face; these spots also broke down into ulcers.

On the vulva the ulcers were round, from half to one inch in diameter, surrounded by a well-marked zone of infiltration, and with no undermining of the border. The discharge was slight and was serous in type.

In the mouth the lesions were similar but smaller. In both, the lesions began as nodules, but the initial nodular character of the lesions and the evolution of ulcers by the development of central necrosis in the nodules was more clearly observable in the lesions on the skin. All the lesions were excessively tender.

Healing took place without marked destruction of tissue, leaving white pliable depressed scars.

A section from a lesion on the vulva showed fibrosis and numerous inflammatory cells, many polymorphonuclear. The vessel walls were somewhat thickened.

Cultures from a lesion on the face were sterile. In direct films some Gram-positive diplococci were seen. A swab from a lesion on the vulva showed a growth of *Staphylococcus albus* and *aureus*, and a few colonies of a Gram-positive diplococcus.

Discussion.—Dr. HALDIN-DAVIS said that a year or two ago Dr. Ravell, who worked in the V.D. department of the Royal Free Hospital, described a case of recurrent ulceration of the vulva and mouth, which bore many resemblances to the present one.[1] After prolonged investigation that case still remained a mystery.

Dr. C. H. WHITTLE said that he had a case similar to this, but without such extensive skin lesions as Dr. Hunt had described. The patient was a girl aged 19, who said she had had these lesions of mouth and vulva since she was 5 years old. Usually they were about the size of a pea, but they might be as large as an inch in diameter; they were very painful. They usually lasted three weeks and she had seldom been free from them for more than a week at a time. He took her into hospital for as thorough an investigation as he could make, with the aid of his colleagues, including a test-meal, but there was no deficiency in the free hydrochloric acid, though the hæmoglobin was low—only 70%. He could not find *Bacillus döderleini* or *Bacillus crassus*—which were probably one and the same—but in the ulcers of the mouth abundance of streptococci were found. He tried the intradermal reaction with this organism, which gave a positive flare. Therefore a series of intradermal injections were given, starting with small doses, and the patient certainly was better afterwards, and had fewer and less severe ulcers. He had had two other like cases which

[1] *Proceedings*, 1932, xxv, 1739 (Sect. Derm. 86).

disclosed streptococci in cultures and films. One patient, a girl, had recovered completely after treatment with autogenous streptococcal vaccine; while a man with recurrent ulcers of the mouth described his condition, after similar treatment, as "85% cured."

Dr. KNOWSLEY SIBLEY said that Jacobi had described a condition which he termed stomatitis neurotica chronica, and he (Dr. Sibley) had described a case of persistent ulceration in the mouth, which was very painful and intractable.[1] That patient had had all her teeth extracted, with the idea that this procedure would cure the ulcers, but it did not.

Dr. A. M. H. GRAY said that in these cases of persistent ulceration of the mouth and the vulva, considerable confusion existed as to their nature. This type of case was very similar to that described by Sutton, under the name "peri-adenitis mucosa necrotica recurrens," probably this was the same condition as that described by Jacobi. It was unfortunate that the word "neurotica" was associated with the name, as the cases were certainly not functional in nature. The cases could be easily differentiated from erythema multiforme of the mouth, and from pemphigus of the mouth.

This was the first case of the kind in which he had seen the ulceration on the skin. Sutton attributed the condition to an inflammatory condition of the mucous glands, but this case might throw new light on this question.

Dr. HUNT (in reply) said she was present at the meeting of the Section when Dr. Ravell's case was shown. In that case the condition had begun in early girlhood, and there was extensive destruction of the vulva, but it was a different type of ulceration from that in the present case, and it was not associated with skin lesions. She herself had had a case like Dr. Whittle's, and in that the condition had cleared up on treatment by heavy doses of iron. In the present case no streptococcal infection had been discovered.

Dr. WHITTLE said that in his case iron might have aided recovery, as the hæmoglobin rose, following large doses of iron, from 70% to 85%.

Mycosis Fungoides.—A. M. H. GRAY, C.B.E., M.D.

The patient is a man aged 59. The first lesion began in the left retro-auricular region, in April 1933, as a red, scaly patch; since then similar patches have appeared in most parts of the body. A lesion in the region of the right angle of the mouth became gradually larger and assumed the character of a fungating tumour. This was treated with four doses, each of one-third of a pastille, between January 22 and February 19, and disappeared rapidly.

Since that time lesions have continued to appear and many of them have ulcerated. In February erysipelas developed on the left buttock, beginning in an ulcerated lesion which spread up to the left groin and across to the right buttock. The condition remained active for fourteen days, and did not respond to anti-streptococcus serum. The temperature reached about 103° F. daily.

The lesions in the area attacked by erysipelas disappeared after the attack but those in other areas have come out more rapidly, have become more prominent, and have shown a greater tendency to ulcerate.

At the present time the patient has a large number of raised red infiltrations varying in size but becoming confluent, particularly over the shoulders. The lesions are thickly set over the forearms and arms, shoulder-girdle, neck, and face, but are scanty on the trunk and lower limbs. A considerable number of them show necrosis and ulceration.

A large number of lesions have been treated with X-rays and have disappeared, but fresh lesions have continued to come out, even in previously X-rayed areas.

There is general glandular enlargement but the liver and spleen are not palpable, and X-ray examination showed no evidence of enlargement of the thoracic lymphatic glands. The blood-count shows no abnormality.

The patient has been treated with arsenic, both orally and by injection, without any appreciable effect. About a month ago he had, in addition, ½ lb. liver daily, and

1 *Brit. Med. Journ.*, 1899.

for a time the lesions appeared to be subsiding. Recently he developed abdominal pains and the liver had to be stopped.

At the last meeting of the Section the President showed a case which had markedly improved as a sequel to malaria therapy.[1] In the present case a rise of temperature for over a fortnight appeared to have rather a deleterious than a beneficial action on the lesions, though the local inflammation cleared up the patches in the affected area for a time.

? Poikilodermia (Jacobi).—A. M. H. GRAY, C.B.E., M.D.

The patient, a man, aged 30, is well developed and, apart from his skin condition, healthy.

History.—He dates his present trouble from a kick received on the outer part of his right thigh ten years ago. Three ulcerated areas appeared on the thigh after this injury and persisted for three years. When they healed they left a discoloured scaly patch. Since that date scaly patches have gradually appeared on the other thigh, the trunk, upper limbs, scrotum, and penis. The patches have never shown any signs of recession. They itch a good deal, especially when dry, but are inclined to become inflamed if ointment is applied.

A piece for biopsy was taken from the right thigh on January 29, 1934; the site was covered with elastoplast, but the wound ulcerated and a severe dermatitis developed at the site of the strapping. This was followed by an extensive generalized papular eczema which has only recently subsided. About a month ago an ulcer developed spontaneously at the root of the penis, causing acute swelling of the prepuce and retention of urine; this subsided without recourse to incision of the prepuce being necessary.

Present condition.—The eruption has a markedly symmetrical distribution; the thighs are the parts most affected, the eruption occupying the greater part of the right thigh and the inner and front aspects of the left. There are patches arranged symmetrically in the region of the anterior and posterior axillary folds; there is a patch in the left iliac region posteriorly, and on the right side, in a somewhat similar neighbourhood, two pale brownish-red areas are appearing. In the midline of the abdomen, below the umbilicus, is a patch about 3 inches in diameter and there are patches in the bends of the elbows and in the popliteal spaces. There is also some involvement of the skin at the root of the penis. The face, scalp, and neck are quite free from any lesions and the mucous membrane of the mouth is unaffected.

The individual patches are well defined, yet the margin gradually fades away into the surrounding skin. The patches themselves are of a faint purplish-red colour and are scaly, and the skin is markedly thinned, having a fine crinkled appearance when picked up with the fingers. This is more noticeable in the centre than at the periphery of the lesion. No telangiectases are visible. Around the more recent lesions an ill-defined zone of a pale brownish-red colour extends for some distance and the new lesions on the flanks show only this change in colour without any definite atrophy. Apart from the skin changes, no other abnormality can be found.

The Wassermann reaction is negative and, except for some eosinophilia, the blood-count is normal.

Therapy.—The patches have been quite uninfluenced by any treatment. The only local treatment that has given any relief is the application of cremor zinci. Other ointments appear to irritate. X-ray treatment produced no change in the patches. The patient, on two occasions, was treated by autohæmotherapy; this appeared to help with regard to the eczema, but had no influence on the patches. He had five injections of gold (lopion 0·1 grm.) without any apparent effect.

[1] *Proceedings*, 1934, xxvii, 1365 (Sect. Derm., 67).

Histology.—Sections were taken from a portion of skin removed from a patch on the outer part of the right thigh. There is a very dense cellular infiltration occupying the outer half of the corium. The papillæ are immensely swollen, and the inter-papillary processes elongated and thinned. The surface epidermis is markedly thinned, the basal layer is œdematous and the cells are becoming disintegrated. There is a patchy hyperkeratosis and parakeratosis. In the papillæ the capillaries are engorged, and there is in some parts a closely packed lymphocytic infiltration, though in most parts large numbers of lymphocytes are found in a loose-meshed network in which broken-up collagen bundles are also present. No pigment granules were seen. In the deeper layers of the corium there is slight lymphocytic infiltration around the vessels, and the vessels are engorged and their walls thickened.

The case is one of patchy atrophodermia with a curious symmetrical distribution. It is singularly like the case described as one of Jacobi's poikilodermia by J. E. Lane (*Arch. Derm. and Syph.*, 1921, iv, 561), but differs from it, and from most of the cases included under this term, by the absence of visible telangiectases, hæmorrhages, and the deposit of pigment. Although it is difficult to apply Jacobi's full title, "poikilodermia atrophicans vasculare" to the condition, it is difficult to imagine that with other characters so similar, the absence of visible telangiectases, etc., can affect its relationship to this class of case. Probably it would be better to include these cases under a general designation of "atrophodermia en plaques."

Dr. H. CORSI, referring to the statement of Dr. Gray that there was little or no telangiectasis, said that it seemed to him that there was quite a noticeable amount.

Infiltrating Carcinoma of the Scalp.—A. M. H. GRAY, C.B.E., M.D.

Patient, female, aged 67. Her left breast was removed on account of carcinoma in 1923. Some years later nodules appeared in the scar, and in 1932 two courses of X-ray therapy were given for this.

About eight months ago she felt a burning pain on the top of the head, and the hair fell out. More recently lumps have appeared on the scalp. Since the trouble began on the scalp she has noticed a hard lump on the left side of the neck.

Present condition.—The vertex and frontal regions are entirely devoid of hair, while hair-growth is unaffected in the temporal and occipital regions. In the bald area the skin is very shiny and much infiltrated so that it cannot be picked up at all and it appears to be completely adherent to the skull. The skin has a purplish colour and large numbers of dilated vessels are visible. Scattered through this area are numerous hard nodules varying in size from that of a hazel-nut to that of a cherry. A few similar nodules can also be felt in other parts of the scalp. There is a mass of hard glands on the left side of the neck, adherent to the deeper structures, but none can be made out on the right side. X-ray examination of the skull shows that there is some involvement of the outer surface of the bone. There are a considerable number of hard nodules in the scar of the breast-operation and in the surrounding skin.

Comment.—The case resembles very closely one shown by Dr. Goldsmith in 1929 (*Brit. Journ. Derm. and Syph.*, 1929, xli, 270). Although no biopsy has yet been carried out in this case, there can be little doubt that the lesion is a secondary deposit from the breast carcinoma. The skiagram suggests that the growth began in the superficial tissues and not in the bone.

Lupus Erythematosus of Scalp.—C. H. WHITTLE, M.D.

M. H., a single woman aged 39.

There is a four years' history of a spreading patch of baldness on the top of the scalp. Recently a new patch has appeared in the right parietal region. She was seen by me for the first time yesterday. She had a tuberculous ankle about fifteen years ago.

There is a smooth, shiny atrophic bald patch, 3 in. across, on the top of the head, with a raised, red scaly edge, the scales being thick and adherent. It has never suppurated. The newer patch shows as a red, slightly infiltrated plaque in the right parietal area, is covered with scale, and shows a slightly depressed centre. There are no lesions elsewhere.

The catamenia ceased five years ago, one year before the patch was noticed. The patient has some bad teeth, but otherwise there is nothing obviously wrong. She has not felt as well as usual during the last few months.

Tuberculin skin test (Mantoux) strongly positive.

Streptococcus hæmolyticus toxin skin test positive.

Section of Odontology

President—Sir NORMAN BENNETT, M.B., L.D.S.E.

[*April* 23, 1934]

The Saliva

By Dr. FRANS DUYVENSZ (Amsterdam)

IT is not without some qualms that I am complying with the request to speak about saliva, for did not Antony Leeuwenhoek, a fellow-countryman of mine, write more than a hundred papers for the Royal Society, and was it not in 1683 that he first informed the Society of his saliva research, in the course of which he made the first discovery of the germs, which he named "animalculæ"? I propose to treat this subject chiefly from a clinical standpoint, and to view it from the angle of one engaged particularly with the question of pyorrhœa. Many years ago I began to wonder why so little interest was taken in the fluid which bathes those parts to which we daily give treatment. The nerve specialist, the urologist, the specialist in intestinal disorders, etc., examine not only the organs and tissues but also the composition of the fluids, and it is often possible for them to bring about changes in the tissues by means of chemical reaction of the fluids.

While this idea was becoming more and more deeply rooted, other dentists made discoveries which tended to strengthen my views. The first question that arises is: "Does there exist a special equilibrium between the tonicity of the mucous membranes, etc., more particularly between the calcium and phosphorus contents of the teeth and saliva and the tonicity of the mucous membrane?" The answer to this question, besides having some bearing on the saliva, depends in the first place on the further question whether metabolism continues in the enamel of a tooth after it is erupted, and if so, whether this metabolism is dependent only on the tooth pulp, or on the saliva, or on both.

Although there is, as yet, no general agreement on this point, we may assume that the enamel of a live tooth is not an enclosed entity, since it may be presumed:
(*a*) That a stream of serum passes from the saliva through the tooth to the pulp, or
(*b*) that a stream of serum passes from the pulp through the tooth to the saliva.

Now it is quite possible that in the course of time such a stream thickens in the outer layer and the permeability is interrupted, as has been demonstrated, I believe, by Fish, through the cornification of the organic matter in the enamel periphery.

It is also possible, without there being any direct connexion with the serum, that calcium salts in the saliva are deposited in the periphery of the enamel.

Since Fish does not preclude the possibility that calcium salts are conveyed from the pulp to the permeable layer still later, his theory greatly attracts me and so we

arrive at the remineralization theory of Andresen, who is of opinion that the tooth is able to absorb from the saliva those salts which are necessary to its existence. When in the further course of this paper I speak of saliva, I refer not merely to the product secreted by the salivary glands as such, but I mean the liquid found in the mouth cavity, in which are included the product of the salivary and mucous glands and a large number of leucocytes which have passed through the epithelium; it may also contain mucus from the pharynx and even some of the secretion from the lachrymal gland, which flows through the nose to the nasopharynx, and also exfoliated epithelium.

One may of course also assume that the mucous glands function normally, likewise that the ducts are normal and that neither saliva nor mucous gland fistulæ exist.

The principal reason why I took up research on the saliva is the well-known fact that in the case of a few patients who are subject to caries the tooth at once begins to decay as soon as the gum recedes if only a trifle, and a small portion of the root not covered with enamel is exposed.

As a contrast we have our pyorrhœa patients. With them it may occur that the upper gum, for instance, has receded so much round about the molars that an ideal resting-place for particles of food is formed between the three roots. And yet caries does not set in even when this condition continues for some time. It was therefore obvious that something must be causing this great contrast, and I wondered to what extent the saliva was involved.

In order to subject saliva to a physical, chemical and microscopical examination we must first secure it. And this constituted the initial difficulty. With animals it is possible to collect saliva by making salivary fistulæ. But according to Pagliai, if one were to tap off all the saliva, or if all salivary glands were removed, most test animals would die within fourteen days. Achard, who reports this in "The Contact Point," states that Pagliai attributes the fact of test animals becoming cachectic and dying, to the salivary glands having also an endocrine function, which seems indispensable to the animals, for when he gave them the extract of salivary glands they did not die. Whether the endocrine function is the only cause must for the present remain an open question. Cahane and others considered that the entire extirpation of the salivary glands led to the appearance of sugar in the urine and the blood.

It is of course our intention to maintain conditions in vitro as far as possible as we find them in the body. Therefore, if we extract fluids we must also take care that we do not start too many processes which might bring about a physical, chemical, or microscopical change. We must consequently commence by not giving our patients or test animals anything that might in any way influence the secretion from the glands; otherwise we do not see the saliva in the state it would be if secreted physiologically. If we *do* influence the secretion, we obtain a kind of saliva which might be termed "stimulated saliva" that is to say a flow of saliva which has been brought about by the stimulant administered to the patient. Becks has likewise demonstrated that even such mild stimulants as chewing and sucking are responsible for a change in pH value. Such saliva contrasts strongly with normal resting saliva, though what is really meant by normal resting saliva is not very clear to me. I would accordingly suggest that we try to exclude as far as possible also all psychical influences. Joy, sorrow, anger and anxiety have been proved to affect the saliva considerably, and so it is possible that the saliva obtained from a patient who has never had such an experience before and is more or less anxious because he does not know what is going to happen to him, will differ greatly from saliva obtained from the self-same patient in the very same way on a later occasion, when he is better acquainted with the process. In other words, never draw conclusions from *one* saliva test.

On the subject of effective influencing of saliva secretion, Wittkower and Pilz have recently made important statements. After obtaining saliva from a number of persons in a normal state, they brought these persons under their influence and induced in them—when in a partly vigilant and partly hypnotized state—joy, anxiety, anger, etc., with the following results:—

(1) Homogeneous affects: always caused similar changes when repeated with the same person. (2) Homogeneous affects: caused different changes in different persons. (3) Dissimilar affects: induced similar changes in the same person.

From this it would therefore seem that in some people each and every affect—joy, sorrow, anxiety, anger, etc.—causes an increase of saliva secretion, whilst there are other persons whose saliva secretion decreases with every affect. No matter how it is caused, a change takes place in the permeability of the cell wall (epithelium) with every increase or decrease of saliva secretion of the salivary glands. Of late there has been a tendency to attribute this change to one or other constituent of the blood-plasma. It is not the oxygen in the blood, for if Ringer's fluid, plus oxygen, be passed through an extracted salivary gland, there is no normal secretion, but secretion occurs immediately when a little blood-plasma is added.

Secretion calls for an enormous amount of energy in the salivary glands; this will be understood when one considers that 1,000 to 2,000 c.c. of saliva can be secreted daily. As salivary glands weigh less than 2 oz. (60 grm.) on an average, it would appear that in a single day these glands secrete more than twenty times their own weight in liquid. This is the more remarkable when one considers that the greater part of this saliva is secreted during meals, and in this connexion it is interesting to note the observations of Kuss, who showed that the parotid produces fifty times more saliva during chewing operations than when the mouth is at rest. Without going into the physiology of saliva, I would call attention to the fact that the gland secretion, quantitatively as well as qualitatively, is regulated by the nervous system and the hormones, and that, according as one or the other reflex centre is stimulated, an abundant easy-flowing watery saliva or a highly viscous substance is obtained. When dry food is taken there is an abundance of thin saliva; with food that is more difficult to swallow (e.g. tough meat) a secretion of viscous saliva. If it were possible to carry out the researches in the mouth cavity, this would of course be the simplest procedure. In determining the pH, for instance, it has been found that the carbonic acid pressure has some influence and that this is more or less lost as soon as the saliva leaves the mouth. It becomes more and more pronounced according as the saliva is retained. In order to determine the pH it is now possible to carry out the tests within the mouth, as I shall presently show; but most tests must be made outside the mouth, and for this purpose the saliva has to be collected. When collecting saliva the greatest possible care must be taken to see that as little carbonic acid pressure as possible be lost. This can partly be insured by placing a little liquid paraffin in the tube used for collecting the saliva. There are various ways of collecting saliva, but the way I often do it is to fit a small glass cylinder in the saliva-pump (fig. 1).

As I like to test various reactions in saliva I try preferably to collect 20 c.c., but one will not always succeed in collecting so much saliva without entirely exhausting the patience of the patient. As a rule I obtain the 20 c.c. of saliva in some thirty minutes, and I regard this as normal, but it sometimes occurs that we cannot get even 10 c.c. in sixty minutes. On the other hand there is also a possibility of there being an exceedingly rich flow of saliva and that 20 c.c. can be collected in a very few minutes.

A patient, aged 58, was once sent to me by a colleague for saliva examination. On being questioned the man told me that he had had stomach trouble for many years and that his stomach always felt puffed up and, further, that he was often

inclined to vomiting and diarrhœa. As the patient travelled a great deal, he was treated by specialists in various parts of Europe, but in vain. This information was merely noted and at first given no further thought. After a time it was decided to obtain some of the patient's saliva. We did so by means of a saliva-pump with a test-tube intervened. The patient was told to advise us when the saliva had reached the 20 c.c. mark on the tube. We expected that he would call us after about thirty minutes, which is normally the average time taken, but barely eight minutes had elapsed when we were informed that the saliva had already reached the 20 c.c. mark. Surprised at such rapid secretion, we gave him a second test-tube and within fifteen minutes the tube was again filled to the 20 c.c. mark. On questioning him further, we were informed that he often had so much saliva in his mouth that he was obliged to spit in the street and that in company he had great difficulty in swallowing it. This aroused our suspicions, and, in consultation with his doctor, a dose of belladonna was

FIG. 1.

administered; this quickly took effect and reduced the saliva secretion. Beaming with happiness the patient came back two or three weeks later to say that not only was he rid of the inconvenience caused by the excess of saliva, but the stomach trouble, from which he had suffered for so many years, had also disappeared as if by magic.

On another occasion I had a case which was just the reverse. A girl aged 17 was sent to me to have her saliva examined because her teeth were badly attacked by caries. With the saliva pump, with a test-tube intervened, we endeavoured to obtain saliva in the same way as with the other patient, but after half an hour we had collected no more than 3 c.c. This extremely poor result naturally set us thinking again and as no mechanical causes could be found, it occurred to me that we might examine the urine to see whether there was any sugar present. We all know that in diabetes, the saliva secreted is often slight. Our suspicions proved to be correct, for the urine when tested for sugar showed highly positive results, and this patient, who had never before been examined for diabetes, was thereafter treated for this

complaint. These two instances have impressed upon us that merely the fact of having noted how long was required to collect a given quantity of saliva, enabled us to render, perhaps unexpectedly, a great service to the patients.

This brings me back to my own research work during the last few years and I propose to deal with: (1) Hypophyseal hormones in saliva. (2) Hydrogen-ion concentration. (3) Calcium in saliva. (4) Sulphocyanate in saliva.

Hypophyseal hormones in saliva.—In the cavity of the sella turcica there hangs on the lower part of the brain a more or less globular organ the size of a hazelnut called the hypophysis cerebri or pituitary gland, consisting of an anterior and a posterior lobe, with a connecting structure between the two.

During pregnancy the anterior lobe undergoes a change; it becomes larger and most of the cells (chromophobe and chromophile) disappear in order to make room for Erdheim's so-called "pregnancy cells." After pregnancy these "pregnancy cells" disappear and the hypophyseal cells once more come in their place. This demonstrates the influence of the hypophyseal hormones on the genital organs. Some years ago Aschheim and Zondek found that the entire female organism overflowed, as it were, with hypophyseal and ovarian hormones and that these hormones occurred in the urine. This fact induced me to see whether a biological reaction might be used with the saliva to indicate pregnancy and this proved to be the case.

In conformity with Zondek's test the saliva was shaken together with "æther pro narcosi Merck," one part saliva to three parts ether for the purpose of detoxication. After the mixture had been well shaken, it was placed before an open window to allow it to evaporate.

As test-animals we took infantile mice, weighing less than 8 grm. The amount of saliva injected into each mouse was 6 c.c. on an average. This was divided into six portions and the injections were given twice daily for three days.

On post-mortem examination after four, five to six days, the following changes were found. (1) Enlarged uterine-cornua. (2) (Often) enlargement of ovaries. (3) Pronounced hyperæmia of the entire genital region, especially of the ovaries.

On microscopical examination it was seen that: (1) Ripening of the follicles was most intensive. (2) Blood reaction in the follicles was slight. (3) The interstitial glands of the ovaries were highly developed and showed an abundant infiltration of lipoid in the theca. The ovaries were often in a state of degeneration. Peculiar yellow bodies were infrequently found.

It would therefore appear that the organism was trying to get rid of the abundance of hypophyseal hormones by way of the kidneys and the salivary glands, and this may be another reason why there is sometimes an abundance of saliva in pregnant women and in persons of strong physique.

At all events it is seen to be possible to diagnose pregnancy by means of biological saliva reaction.

Hydrogen-ion concentration of saliva.—The importance of hydrogen-ion concentration in biology and therapeutics has of late been generally recognized, and I would take this opportunity of congratulating Mr. F. W. Broderick for the way in which he has drawn attention to hydrogen-ion concentration in connexion with stomatology. As is usually the case there seemed to be almost simultaneously a need in various countries to investigate this subject further, and in Holland it aroused my interest many years ago.

The work of Bàlint and Weiss on "Gewebsproliferation und Saurebasengleichgewicht" impressed me greatly as to the important part that the alkali or the acid plays on the body.

These authors have demonstrated that a turpentine injection in the leg of a

rabbit which was alkalized caused only little trouble (fig. 1A (*1a* and *2a*)), but caused a tremendous inflammation and necrosis when the rabbit was acidulized (fig. 1A (*1b* and *2b*)).

There are various methods of determining the pH ; I myself employ two.

(1) Determining the pH with the aid of the Hellige micro-comparator. This

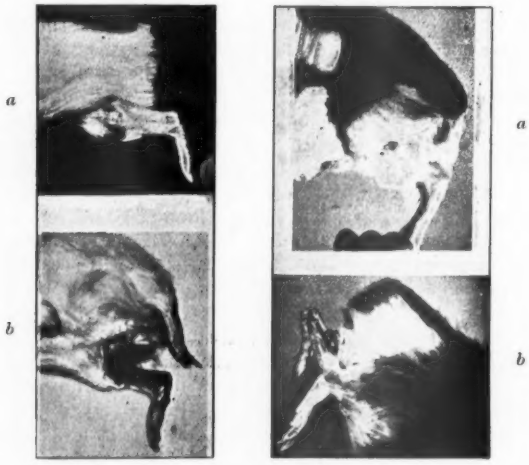

FIG. 1A

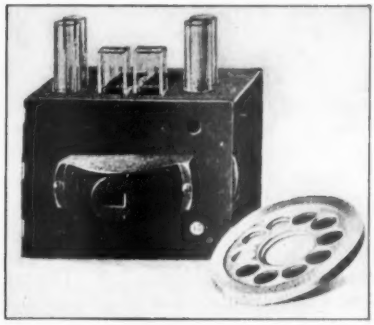

FIG. 2.

has the advantage that, with it, one need make no buffer solution, as there is a coloured glass comparative scale, which is, therefore, constant. In the lid there are two holes into which tubes may be put. In one tube put saliva plus indicator, in the other saliva alone. The tube containing the saliva alone is placed in the opening so that the coloured glass discs are behind it. These discs are then

rotated until the light penetrating through the two tubes is the same colour. The apparatus then automatically indicates the pH, which can be read off.

(2) Determining pH with the Wulff apparatus: "The Folien colorimeter with indicator—by Wulff." This is an apparatus with a number of small films, containing an indicator giving a certain pH, namely films I, pH 2·6-5; II, pH 5·0-7·2; III, pH 7·0-9·0. After these films have been submerged for one minute in the liquid (saliva) to be examined, they are taken out, rinsed in distilled water, dried between filter paper, and compared with a scale supplied, from which it is possible to read off the pH immediately. The advantage of these films is that we know that the carbon-dioxide pressure greatly influences the pH of the saliva. Now if we were able to determine the pH in the mouth cavity itself, we should retain the maximum carbon-dioxide pressure. We proceed as follows:—

Tell the patient not to swallow his saliva, but to keep it in his mouth and advise us when he has sufficient.

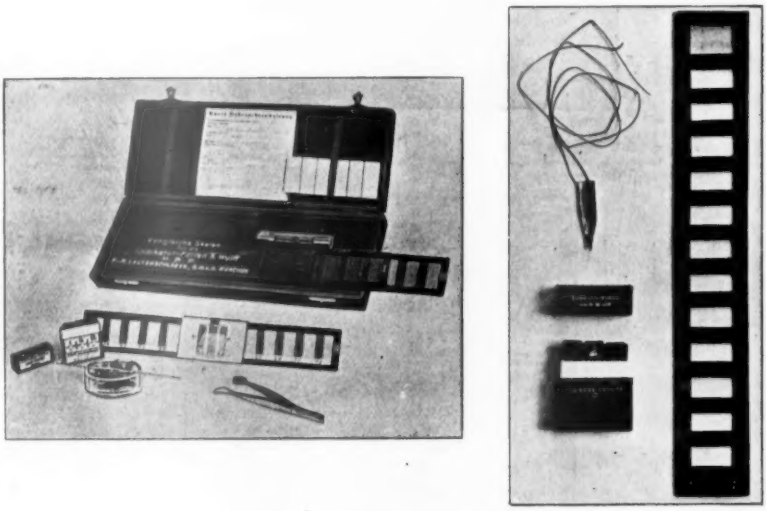

FIG. 3.

We begin with film II, because this gives us a pH round about the neutral point. In this film we punch a hole with rubber-dam forceps and through the hole we pass a thread, which we hold so that the patient is unable to swallow the film.

After waiting one minute we take out the film, we rinse it in distilled water, dry it between filter paper and then compare it with the scale, which at once shows us the pH.

A second advantage is that with the aid of scissors one can point the film and insert it, for instance, between the teeth. The pointed portion shows the pH at this spot. The pH, by the way, may be different in different parts of the mouth cavity.

Both these methods may be applied to urine, blood-serum, and fæces. I do not propose to examine the prospects that the determining of pH offers in connexion with the question of caries and pyorrhœa; I would merely advise you to examine

also the buffer action of the saliva after determing the pH, because this gives a better idea as to whether the medical treatment has been a radical success. I do this in the following way. Let us assume that the saliva has a pH of 6. I now ascertain how much acid I must add to obtain pH 5 and how much alkali to obtain pH 7.

FIG. 4.

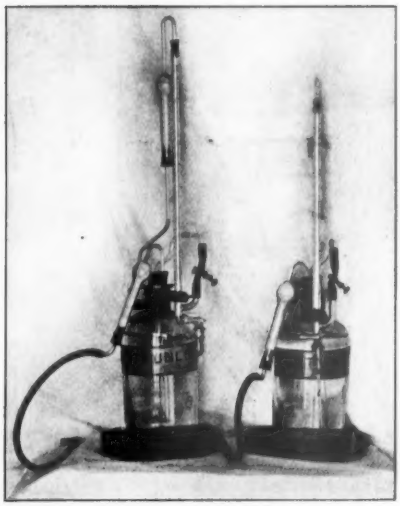

FIG. 5.

In this way I can see whether the saliva is well buffered with regard to the acid and the alkali respectively.

If I need much acid or alkali to obtain these figures, then the saliva is well buffered. If I need only little, the saliva is badly buffered. Therefore, if, for instance, I obtain the pH 5 after adding only a small amount of acid, whereas after

dieting for a time I must add double the amount of acid before reaching the pH 5 it proves that my dieting has had a good effect. One must work, as far as possible, under equal conditions, as I have found that the amount of acid or alkali needed to bring the saliva of one and the same person to a given pH on different days varies considerably. If one adds alkali or acid to a buffer solution consisting, for instance, of a weak acid and a salt of this weak acid, the pH of the buffer solution changes in the order of the curve in fig. 6.

In the case represented here the saliva would have a pH of 7·1. To arrive at a

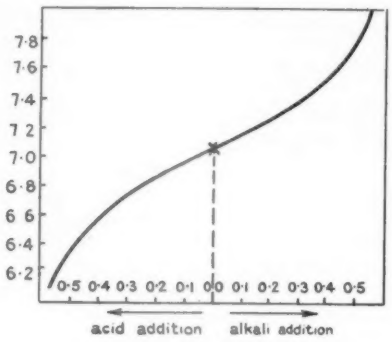

FIG. 6.

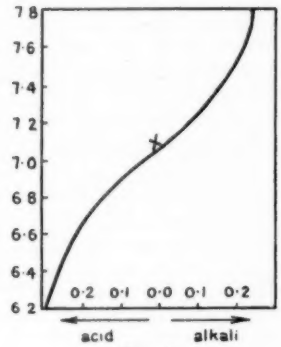

FIG. 7.

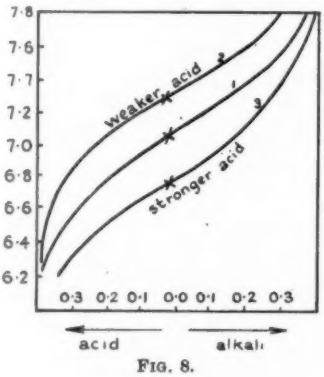

FIG. 8.

pH 6·4 one would have to add 0·47 c.c. of acid, and to obtain a pH of 7·8, 0·45 c.c. of alkali.

If the saliva had the same constituent parts, but was more diluted, the position of the curve would be the same, but the horizontal section would be shorter (fig. 7). In this case a smaller quantity of alkali and acid would be needed to arrive at a pH of 7·8 or 6·4 respectively: namely 0·25 of each. This is therefore the outcome of diluting an otherwise unchanged composition. The pH of the saliva is the same in both of the foregoing instances. Should the pH value of the saliva be different, this may be due to two factors. In the first place the composition may vary quantitatively owing to the saliva containing a stronger or weaker acid than in the first instance. This would cause the curve to rise or fall (fig. 8).

(1) has a pH of 7·1 ; the weaker acid (2) is pH 7·3 ; the stronger acid (3) is pH 6·8.

In order to arrive at pH 6·4 we should require the following quantities of acid: For (1) 0·35 c.c. ; for (2) nearly 0·4 c.c. ; for (3) 0·27 c.c. Alkali to pH 7·8 : for (1) 0·37 c.c. ; for (2) 0·30 c.c. ; for (3) nearly 0·4 c.c.

A stronger acid in the saliva therefore means that less acid and more alkali is needed in order to arrive at a given pH. In the above graph it is assumed that the composition of the saliva was in the middle of the curve, that is to say, there was an equal quantity of acid and salt present. Generally speaking this will not be the case.

In Case 9 (fig. 9) the curve given is the same as in Case 6, but the saliva now contains more of the acid and less salt. The pH is consequently lower, namely 6·85, and the amount of acid required to arrive at pH 6·4 is 0·28 c.c. ; the amount of alkali to arrive at pH 7·8 is 0·7 c.c.

From fig. 8 it further follows that two types of saliva, of different compositions, may have the same pH but different buffer actions.

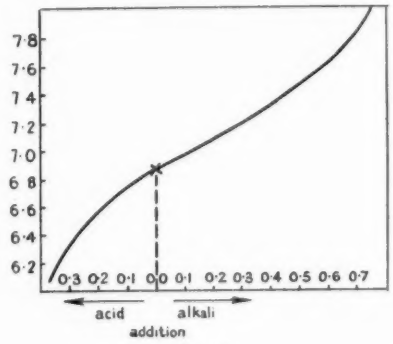

FIG. 9.

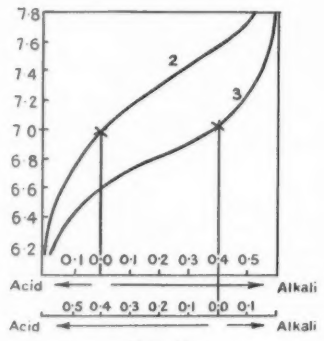

FIG. 10.

In fig. 10, Curve (3) represents a stronger acid, Curve (2) a weaker one. If (2) consists of much acid and little salt and (3) of little acid and much salt, these two have the same pH, namely 7·0. In order to arrive at pH 6·4, (2) needs 0·17 c.c. of acid, whereas 3 needs 0·55 c.c. The saliva (3) has thus a better buffer action in respect of acid than saliva (2), though the pH was the same. When alkali is concerned we have the reverse. No. (2), then, buffers better than (3).

Thus the assertion that patients with a strong tendency towards caries have a saliva lower than 7 (that is, acid), and those who tend towards pyorrhœa have a saliva higher than 7 (that is, alkaline), is not quite correct. The degree mainly depends on the salts which are present in the saliva, namely, the phosphorus, and, particularly, calcium salts. In cases in which a person immune against caries has contracted pyorrhœa, we find that pyorrhœa has come about through lack of calcium in an acid saliva. And this brings us to the consideration of the calcium content.

The calcium content of the saliva.—I make a habit of examining not only the saliva but also the urine. Both liquids are easily obtained. If possible the blood should be examined as well, but as a rule urine and saliva illustrate only too well for our purpose what is going on in the body. The normal reaction of saliva should be about neutral, with a tendency towards the alkaline side. The normal reaction of

urine is weak acid. Now if the reverse is the case, i.e. the urine alkaline and the saliva acid—something must be wrong. This state of things is found in people who do not pay attention to their diet, who eat hardly any fruit or greens, but take quantities of starchy foods. Such conditions are also found in pregnant women and in persons who have for a long time suffered from some infection. A human being needs, at least, ½ to 1 grm. of calcium per day. The calcium is secreted, for the greater part, by the intestines, to a lesser extent by the kidneys. With a normal diet approximately ¼ to ½ grm. is secreted in the urine daily. Calcium is also secreted by the salivary glands—approximately 9 mgm. %—principally by the parotid. We know that there is a close relationship between the phosphorus and the calcium contents in the body fluids, and that changes in the calcium content are often preceded by changes in the phosphorus content.

In an alkaline saliva we generally find the phosphorus content low and the calcium content high. In an acid saliva it is just the reverse. This same characteristic is found in urine. By discharging or by retention of phosphorus along the urinary system the phosphorus content of the blood is once more regulated. In a case of caries, where we have an acid saliva we shall want to alkalize it. In doing so, we must see that the intake not only of calcium, but also of phosphorus, is regulated. Matters must be so arranged that the saliva reacts alkaline and the urine acid. In this connexion it must be borne in mind that the mono-phosphates are acid and the dibasic phosphates alkaline. In regulating diet it must further be remembered that vitamins also play an important part. Vitamin D, for instance, causes an increase of phosphorus absorption in the body, which fact in turn indirectly affects the calcium content. At this juncture I might perhaps mention that two other Dutch medical men, Dr. Metz and Dr. Coppens, have just stated that: "Researches into the fate of orally administered ergosterol in the dog have demonstrated among other things that this substance is destroyed by the lungs." Vitamin C in the form of orange juice contains, for fruit, a rather high content of calcium and phosphorus.

Up to the present we have been accustomed to regard calcium in body fluids as a unit. But for some years tests have been carried out in Professor Snapper's laboratory at Amsterdam which prove that the body fluids, which have so far been regarded as a unit, have, in fact, greatly contrasting calcium-operating powers. Professor Snapper carried out researches on blood-serum with a view to finding a method of separating the various serum colloids from each other, without causing any change in the chemical and physical qualities of the serum. To this end he applied ultra-filtration, and for this purpose he made collodium bags on the Greenberg and Gunther principle, but altered them so as to make them more or less permeable at will, according as they remained for a longer or shorter period in the alcohol-ether solution. The permeability may be checked, for instance, by examining the permeability of a gold solution in which the size of the gold particles are known.

The collodium solution is made in accordance with the prescription of Green and Gunther: Seven parts by weight of Schering collodium wool are dissolved in a mixture of 60 parts of absolute alcohol and 40 parts of ether. To each 100 c.c. of this collodium solution are added 5 c.c. of ethylene glycol to make the bags sufficiently strong. The bags are made in glass tubes shaped like a common centrifuge tube, but a trifle wider. The tubes are thoroughly rinsed with distilled water and dried in a portable drying oven. The bags are moulded in room temperature as follows: The glass mould is nearly filled from the stock of collodium solution. The contents of the tubes are then poured into another bottle, being rotated on their longitudinal axes until not a drop of collodium is left in them. The process may be repeated. Then the tube should be hung upside down in the air (ten to fifteen minutes) until the collodium layer no longer smells of ether. The tube is then filled with distilled water to remove the excessive alcohol from the collodium skin. The water is renewed, first after ten minutes and again after five minutes. About five minutes after this second

renewal the water is thrown away and with the aid of tweezers the moulded bag from the wall of the tube is carefully removed. The bag should then be clear and colourless. If it is milky, this is a sign that the ether in the tube was not properly evaporated.

When it was desired to make membranes to serve as filters for serum proteins, Prof. Snapper proceeded as follows: First he made membranes in the way described above, except that he waited seven minutes between the first and second fillings of the glass moulds. The membranes were then put for from five to fifteen minutes in absolute alcohol. If desired from 1 to 3 % ether may be added. The longer the membranes remain in the alcohol and the greater the ether concentration is, the greater will be the permeability of the collodium membrane. After five to fifteen minutes the membrane, which is swollen and very soft, is rinsed for about twenty minutes in distilled water, the water being renewed two or three times. The membrane can then withstand a filtration pressure of 8 to 15 cm. mercury. To remove the last remnants of the alcohol, distilled water is first drawn (sucked) through the bags.

Fig. 11 shows the apparatus for ultra-filtration as used by Professor Snapper. *H* indicates the collodium bag with serum, entirely suspended in the receiving tube *A*.

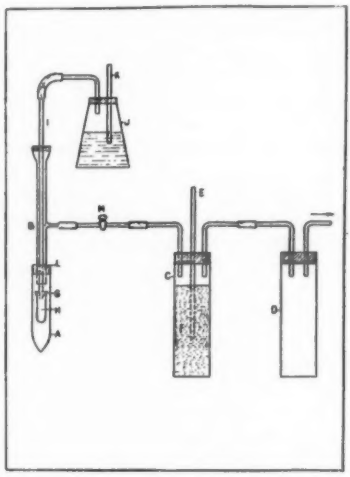

FIG. 11.

This tube is connected by tube *B* with the automatic pressure regulator *C*, which is for three parts filled with mercury. By putting tube *E* in the mercury it is possible to regulate the suction pressure (150 mm.). The space above the mercury is in communication with the water suction pump. The bottle *J* contains a phosphate buffer solution of pH 7·4, to each 100 c.c. of which has been added 0·1 gr. of bicarbonate of soda to keep the carbonic acid pressure over the serum constant.

The calcium, which belongs to the kat-ions of the saliva, associates with two an-ions of the saliva, namely carbonate and phosphate, two only slightly soluble salt compounds, of which, according to Rond and Takahaski, the soluble portion has, with the exception of a small constant remainder, all its ions split. Rond and Takahaski further demonstrated that the calcium-ion concentration is dependent on the hydrogen-ion concentration In the case of hydrogen-ion concentration of blood, with a pH of 7, the calcium-ion concentration proved to be about 2 mgm. per 100 c.c.

For the calcium and phosphorus system, Holt and Hasting found that the value of the constant of the soluble product of the carbonate phosphate is reduced by the degree of activity of the serum, so that the serum can contain at most 3 mgm.% calcium in ions. Since it is possible to alter the permeability of the collodium bags at will, we are able to make bags which allow the passage of albumin, but not, or at least practically not, the passage of globulin, for globulin has a much coarser dispersion than albumin. In investigating the calcium content of albumin, which is found by ultra-filtration, Professor Snapper calculated that the so-called associated calcium fraction of the blood-serum (for a part of the calcium does not associate) is associated exclusively with the albumin. In a case of œdema it appears that the albumin content is much greater than the globulin content. Now this is to be understood, because the membranes in the body naturally first allow the passage of the smallest dispersion, which is the albumin.

The calcium is, as we have seen, associated with the albumin, and I imagine that in cases of infection—for instance in pyorrhœa—the serum calcium can also come out with the albumin, owing to the greater permeability of the membranes—in this case the blood-vessels—and accumulate in the pocket. Up to this point I have tried to show you the great influence of the pH on the different processes in the body, and that it may be possible to have a pyorrhœa though the saliva is not alkaline but acid, and that in my opinion the calcium at the bottom of the pocket does not come from the saliva but from the albumin that has passed through the altered blood-vessels and contains most of the calcium.

This brings me to the next point in my paper.

Sulphocyanate content of the saliva.—There is hardly a constituent of mixed saliva about which so much has been written as about sulphocyanate, but in spite of this we know very little about its purpose. We *do* know, however, that it is always found in human saliva.

For a long time it was thought that caries had some close bearing on sulphocyanate, and it was assumed that the more of this substance was contained in the saliva, the more immune a person was against caries.

My own experience has shown that normally there is fluctuation of 0·05 to 0·17 mgm. of calcium sulphocyanate daily; the figure being highest in the morning before breakfast and lowest in the evening, whilst concentration increases during the night. After meals too there is an increase of the content in the saliva. Any great deviation in the sulphocyanate content, either upwards or downwards, indicates a pathological condition (diffuse liver diseases, uræmia, zystinuria, etc.). Reissner and Smeink demonstrated that in the case of both children and adults, the highest sulphocyanate was often found in those most affected by caries, the exact opposite of what they had expected to find. In children they found a sulphocyanate content of 0·0022, in adults 0·0050. From this they concluded that the sulphocyanate content of the saliva increases as one grows older. It appears that Reissner can indicate sulphocyanate even in a child a few months old, a thing which used to be doubted. Apparently sex makes no difference.

Lockmann and Ulrich, who have been carrying out researches as to the germ-killing action of sulphocyanate acid, have demonstrated that its action is strongest as free sulphocyanate acid, owing to the joint action of the hydrogen-ions and that it possesses properties which dissolve the mucigen, but do not develop sufficient antiseptic action in the mouth cavity.

It is not known exactly how it originates in the organism, but the theory is finding more and more acceptance that it is formed by nitrites, which, in their turn, have come about through the decomposition of the carbonic acid from amido-acid and oxydation. These nitrites, are highly poisonous, but through the metabolic action with albumin corpuscles they are rendered harmless, owing to the fact that

they are converted into sulphocyanate in a nascent state. The hydrocyanic acid in animal metabolism comes in the main from the vegetable kingdom, where it is found in abundance. Most researchers consider that the sulphocyanate content is greater in smokers than in non-smokers. Vogel was the first to indicate sulphocyanate compound in tobacco smoke. Toth found in the smoke of Hungarian cigars an average of 0·027% of cyanate compounds calculated to be thiocyan; and Becks showed that after the smoking of a cigarette there was practically no increase in the sulphocyanate content of the saliva, but that there was a considerable increase after the smoking of a cigar. Albrecht, Beythin, and Toth showed most decidedly that there were thiocyanate compounds in tobacco smoke.

In his Cartwright lecture on pyorrhœa alveolaris Broderick cites the case of a young man, aged 20, who had pyorrhœa in a highly advanced stage and who was found to be living in circumstances "which would account for the condition." As leader of a band, he played the greater part of the day in a restaurant, and had hardly any physical exercise. His surroundings were dusty and badly ventilated—a state of things which quickly gave rise to anoxæmia. Secondly, this patient was absolutely immune against caries, a fact which tended to prove that he had metabolic equilibrium, which would easily compensate the acids formed in the processes of life, but, with regard to the influences due to his present occupation, Broderick rightly considered, that carbon-monoxide poisoning was in a high measure responsible. He pointed out that the anoxæmia might be due, not so much to the lack of oxygen in the air as to the poisoning of the red blood-corpuscles by carbon monoxide; that there was no means of conveying the oxygen and that there must always be carbon monoxide in the air in large towns and badly ventilated apartments. Broderick quotes Dixon, who said that in apartments where much smoking was done, the carbon monoxide concentration rose to 0·01% and that the subjects exposed to this atmosphere were 5%; and by calculation Dixon comes to the conclusion that the carbon monoxide formed in the air by tobacco smoke is sufficient "to affect appreciably the blood-hæmoglobin."

Hartridge found 6% of carbon monoxide in the blood of a moderate cigarette smoker, and pointed out that a normal, healthy man shows no signs of carbon monoxide poisoning until from 15% to 20% of his hæmoglobin is fixed and put out of action, whilst further on Broderick says:—

> "In this discussion we are not considering, however, the matter of acute carbon-monoxide poisoning as such, but rather the possibility of an anoxæmia, the result of unsatisfactory environment. It would seem probable that this might result from tobacco smoke or from the outdoor atmosphere, when there will result a tendency to a disposition of calculus and consequently to pyorrhœa."

Although I fully agree with Broderick's observations, I should like to call attention to a factor, that may be of importance in the contraction of alveolar pyorrhœa, namely, the sulphocyanate content of the saliva.

People who spend their time in smoky rooms are, owing to their environment, nearly all smokers, and those who are not, after all, inhale a large amount of smoke and are accordingly "indirect" smokers. Now we have already shown how the sulphocyanate content generally increases in smokers, but no matter whether the patients are smokers or not, we know that the sulphocyanate compounds greatly affect the blood-pressure, and I consider this an important factor to be taken into account in cases of pyorrhœa, for apart from all other influences the condition of the capillaries is one of the most important features in diagnosing these cases. The sulphocyanate in the blood-plasma is regulated by various factors. One too many causes a fall, one too few a rise, in the blood-pressure. The red corpuscles, which are capable of absorbing large quantities of sulphocyanate, may destroy the sulphocyanate or once more return it to the plasma. In this way they act as

regulators. Many glands secrete sulphocyanate, but the salivary glands more particularly.

The sulphocyanate swallowed with the saliva, for the greater part leaves the intestines with the food; some of it is destroyed and becomes sulphohydrogen, carbonic acid and ammonia ($HCNS+2\cdot H_2O=H_2S+CO_2+NH_3$) and some of it may also be absorbed by the intestinal membranes and find their way into the liver through the portal vein. As far back as 1887 an Englishman named Fenwick published a book entitled: "The saliva as a test for functional disorders of the liver."

I will not deal further with this subject, but I would like to point out that Schechter has proved by his research work that the liver is the principal place in which the poisonous cyanate compounds formed by associating with sulphur—which, as such, occurs chiefly in the liver—are converted into practically non-poisonous sulphocyanate compounds. When the liver is diseased the power to render the cyanate non-poisonous may be broken down; no sulphocyanate can then be formed and the content in the saliva is greatly reduced. One should therefore remember to question the patient with regard to liver complaints.

According to Weinbergen, the hydrocyanate is derived as a finished product from the only sulphuric amino-acid—the zystin or zystëin. Zystëin is an α amino β thiopropion acid. Through oxydation and water decomposition it becomes zystëin, which is an integral part of all albuminous matter. The greater part of albuminous sulphur oxydizes in the organism to sulphuric acid and is secreted in the urine as sulphate. A part, however, is to be found in the urine and in various secretions and excretions as sulphocyanate, where it is secreted by means of the blood. According to the researches of Becker, Hamann and Doeneke a sulphocyanate content of 4 to 10 mgm. % is normally to be found in the blood. In the blood-serum or plasma a content of 1 to 1·8 mgm. %.

The erythrocytes are capable of absorbing the sulphocyanate in a great measure, sulphocyanate content of the plasma and the serum rise to three or five times the more so than the plasma; but in a case of uræmia and kidney insufficiency the normal value; therefore, in the event of a very great rise of the sulphocyanate content in the saliva, one might perhaps do well by trying to picture kidney insufficiency symptoms.

The colorimetric method of testing: In order to determine the content of sulphocyanate in the saliva, in respect both of quality and of quantity, we add liquor ferri sesquichlorate. We then obtain a soluble ferrirhodanide, and then recognize the sulphocyanate by its typical cherry colour. After filtering the saliva we add to it 1 c.c. of the Reissner comparative solution, consisting of:—

5 c.c. sulphocyanate 0·02
0·5 c.c. $FeCl_3$ 1/1 N
1 c.c. 10% HNO_3 (boiled)
3·5 c.c. aqua dest.
} 0·01% sulphocyanate

The fluid, if well bottled and stored in a dark place, will keep for five days. To 5 c.c. of filtered saliva we add 1 c.c. of the Reissner reaction solution consisting of: 80 c.c. boiled HNO_3; 40 c.c. 1/1 N $FeCl_3$; 40 c.c. aqua dest.

For making comparisons we use the Duboscq colorimeter (fig. 12). Both cylinders are filled with an equal quantity, one with the comparative solution and one with saliva plus the reaction solution. The cylinders are then moved from side to side until the two solutions look the same colour. It is then possible to read the content from the scale and to make one's calculation.

As we have already said, too much sulphocyanate causes a fall, too little a rise in blood-pressure.

Now it is known that it is in middle age that pyorrhœa claims most victims. It is striking that just at this time of life changes in blood-pressure are most pronounced. In women the endocrine system plays an important part in this connexion, and when there are fluctuations in the measured blood-pressure we likewise find fluctuations in the average of the sulphocyanate content of the saliva (our average = 0·05 to 0·17 per 1 c.c.). These changes of blood-pressure furthermore cause changes in the capillary system, and changes in the capillary system, in their turn, occasion changes in its permeability, so that we get greater or less secretion of serum calcium which settles on the bottom of the pyorrhœa pocket, among other places. Warwick James and Counsel, who have carried out many investigations with regard to the histological changes in pyorrhœa, state that:—

"Pockets, if examined histologically, are found to be occupied completely by calculus in their deepest aspects. The association of calculus with the progress of the disease depends upon the deposit in the depth of the pocket and not upon the gross collections readily seen."

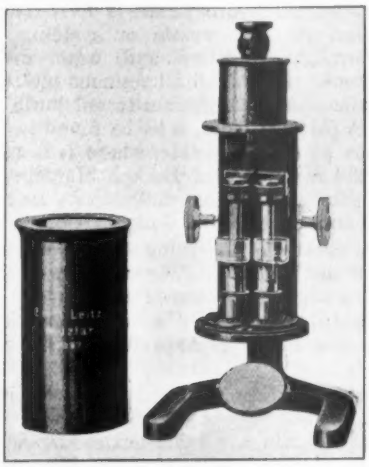

FIG. 12.

The calcium deposit I consider to be another sign of changes in the capillary system, and to show these changes I use this apparatus. My method is as follows:—

The patient, whose head is held in position by the support, is first of all photographed (either the entire head or only the mouth). On the base I place the Leica camera (fig. 13).

Then in place of the Leica camera I put the Leitz microscope tube with the ultro pack-objectives (fig. 14).

Fig. 15 shows how the lenses work.

The light which a monolamp throws in from one side is so highly condensed by the system of lenses that it deeply penetrates the tissues when lenses are brought near the skin or mucous membrane.

Fig. 16 shows the apparatus placed against the lips.

FIG. 13.

FIG. 14.

I also usually examine the gums and the nail-beds of the fingers. In order to render the skin more transparent I rub a little cedar oil on the finger. The microscope may, however, be applied to any part of the skin as desired. If one removes the ocular from the tube and inserts an intervening member the Leica camera can then again be put in position and a photomicrograph of the capillaries can be taken (fig. 17).

If the state of the capillaries in the gums, for instance, is greatly different from the state of the capillaries elsewhere, for example, in the lips and skin, we are then

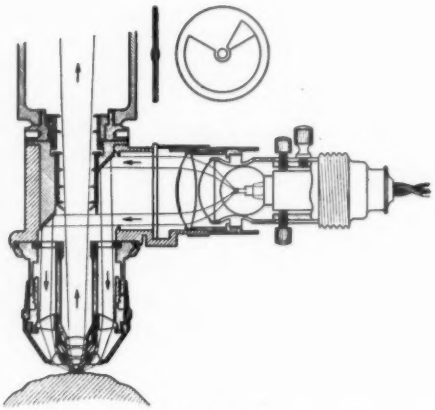

FIG. 15.

concerned with a case of local trouble. If, however, the capillaries in the gums and lips and in the finger show the same deviation, it will be realized that very little could be achieved by local treatment alone and that internal treatment would, therefore, have to be given simultaneously.

I trust that in this paper I have succeeded in demonstrating why we should not say that caries or pyorrhœa is dependent on—let us say—a certain bacterial infection or an acidosis or alkalosis, but that there are these things and a thousand-and-one more which may in some way or other influence these diseases.

Mr. F. W. BRODERICK: In many ways Dr. Duyvensz holds opinions similar to those which I have stressed for a number of years. He, too, seems to consider that dental caries and pyorrhœa are the consequences of essentially antagonistic states. His observations that emotional disturbances alter the physical and chemical characteristics of the saliva agree with mine. He stresses the fact that an emotional stimulus of any kind in the same individual always registers the same changes, whereas these may be different with the same stimulus, in different individuals, suggesting that it is the threshold of emotional stimulation, which differs in different individuals, and is an important factor in secretory activity. This threshold will depend entirely upon the adrenal-sympathetic function, as shown by Cannon, and will be regulated by the inherent balance of the vegetative system of the particular individual. In other words, the chemico-physical properties of the saliva must depend upon sympathetic-parasympathetic balance. This suggestion is upheld by the illustrations that Dr. Duyvensz has given us—the patient with excessive saliva and gastric symptom cured by belladonna (a drug which decreases vagal tone), of both his complaints; and the patient

FIG. 16.

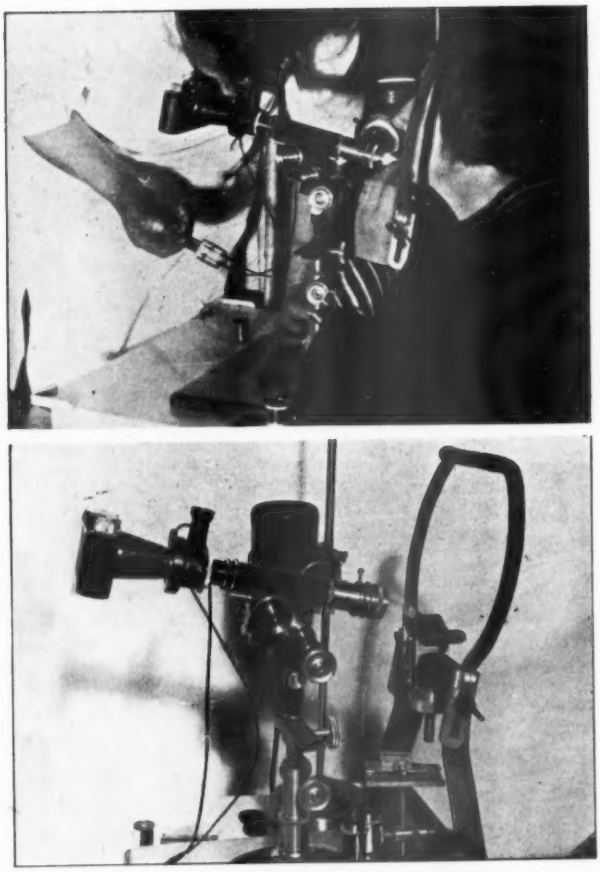

FIG. 17.

with diminished salivary secretion and diabetes, the pancreas supplying, it is presumed, a parasympathetic hormone.

Again, if the carbon-dioxide pressure regulates the reaction of the saliva, this being dependent upon the pressure of the gas in the alveolar tissue of the lungs, which itself is regulated by the carbon-dioxide pressure in the venous blood, we are forced to consider the relationship between salivary reaction and the tendencies to change in blood reaction.

This brings us to the buffering capacity of saliva. I have suggested that if the salivary reaction is taken at the same time as the alkali reserve of the blood, a fair idea of salivary buffers, both acid and alkaline, could be obtained. There is, however, another matter of interest in this connexion, which has not been mentioned, and which I would suppose has some measure of importance: Certain salivas, when expectorated, increase rapidly and considerably in alkalinity, owing to the escape of carbon dioxide; others do not. If a suitable colour reagent be added to the expectorated saliva and this is allowed to stand for, say ten minutes, and then again examined, it will be found to have changed colour considerably; in others this change is trifling. I suggest that this phenomenon is due to the fact that an acidosis, for example, may be due to an excess of acid (carbon dioxide) or to a diminution of alkali; in the former case the colour change will be considerable, in the latter minimal. The reverse, of course, will be the case in alkalosis.

Turning to the relationship between the reaction of the saliva and that of the urine a matter which has recently been called in question: I have had some simultaneous estimations made of the reaction of these two secretions, charts of which I should like to show you. It will be seen from these that a correlation does undoubtedly exist, and if it is remembered that the saliva was secreted at the moment of collection, whereas the urine had been accumulating throughout the whole period since the last collection, during which time the salivary reaction had oscillated, as shown in those charts in which salivary reactions were taken more frequently than urinary, it will be seen that the curves are most peculiarly alike.

In the same way it can be shown that there exists a definite correlation between the reaction of the saliva and the alkali reserve of the blood (tendencies to acidosis and alkalosis) if sufficient deviations are brought about to overcome the action of the salivary buffers. I have shown that by taking massive doses of alkali it was possible to raise the pH of the saliva from 6·4 and 6·8 to 7·4, and at the same time the alkali reserve of the blood from 24·22 millimols to 27·68, combined with the clinical symptoms of acute alkalosis. Furthermore, as these were followed by acute dehydration, an acidosis supervened, when the salivary reactions dropped to pH 5·6 and 5·8, and the alkali reserve to 23·8.

Although these experiments stress a different point of view from that suggested by our speaker, I believe them to be equally important. As to the reaction of the urine however, whether this be acid or alkaline, I would point out that an estimation from a single sample, irrespective of the time of day or to the proximity to a meal, would be a quite useless procedure. We have to remember that although the urine from a twenty-four-hour specimen should be acid, that excreted whilst active gastric digestion is proceeding should be nearly, if indeed not quite, alkaline, representing the alkaline tide of digestion.

Dr. Duyvensz tells us that the dissociated calcium content of the blood-plasma is associated exclusively with albumin, a fact that I did not know, and draws certain conclusions therefrom, tending to show that this is associated with a more easy permeability through the capillary wall, and may be the cause of the deposition of calcium in the pyorrhœa pocket. I am not quite certain that this argument is legitimate. McDonagh states that "hydrated protein particles,"—that is, enlarged particles tending to pass from colloid to coarse dispersion,—"tend to behave as foreign bodies, which enables them to pass more readily than other or smaller particles. The permeability of colloidal membranes is influenced less by size and more by the electro-physical characteristics of the colloidal particles passing through them." Furthermore, with a parasympathetic dominance, with which I associate pyorrhœa, the albumin-globulin ratio is decreased, and I believe that it is an accepted fact that increase in permeability of the capillary wall is associated with an increase in parasympathetic status. However there may be other factors which neither of us have considered.

The relation between the sulphocyanate content of the saliva and the blood-pressures, again, brings us back to vegetative balance, the low blood-pressure with the high sulphocyanate content and the tendency to pyorrhœa, and the high blood-pressure with the low sulphocyanate content and the tendency to caries, if I read him correctly, agrees with my findings. With reference, however, to the relation between sulphocyanate and smoking in its

connexion with low blood-pressure, and with chronic carbon-dioxide poisoning, another factor can be brought into the problem, viz., that of nicotine poisoning. Langley showed that nicotine tended to paralyse the sympathetic preganglionic fibres, which would allow the parasympathetic to take control, which would lower blood-pressure, and also tend to bring about pyorrhœa. Dr. Duyvensz seems to stress treatment by diet but, although we must all realize the importance of this item, I do not believe that it constitutes the whole matter. I have frequently pointed out that the metabolic equation, if I may use that expression, is a matter of intake and output, intake of food and oxygen, output of energy, which must balance if unfortunate results are not to come about. I do not believe that this balance can be attained solely by considering one side of the equation. The matter of the output of energy must be considered, and here we have, amongst other things, the question of the emotions which were mentioned at the very beginning of our guest's paper, as definitely affecting the salivary reaction. I have found that in practically every case of pyorrhœa in comparatively young people there exists a psychological disturbance—an anxiety-state of sufficient extent to bring about a psychoneurosis of some degree. This may be financial, domestic, or sexual, but it definitely exists and, I believe, constitutes such a strain as definitely to upset vegetative tone, and to be a most important factor in ætiology. Finally, we are warned not to say "that caries or pyorrhœa is dependent upon, let us say, a certain bacterial infection, or an acidosis, or an alkalosis, but that there are a thousand-and-one things possible which may in some way or other influence these diseases." I agree, but, I submit that all these thousand-and-one things will be interrelated, in the same manner as that in which Dr. Duyvensz himself brings together such matters as blood-pressure, capillary permeability, albumin and globulin ratios, calcium and phosphorus ratios, and many others which have been advanced by himself and by other writers, all working to the same end, and all connected together through the vegetative status of the individual, as visualized by Kraus and Zondeck. Altered chemical relations are not haphazard; they exist together according to definite laws, the main features of which are regulated by the chemico-physical properties of the body colloids, which themselves are regulated and controlled by the vegetative system. If we are to believe at all in the constitutional element in disease, which will include even such matters as individual susceptibility and immunity, the matter of the peculiar chemistry of the individual correlates these thousand changes, and they can all be brought down to one fundamental point, a disturbance of vegetative balance, which will be responsible for alterations in the reaction of the tissues and for changes in the ionic ratio, the hormonic balance, and the metabolic efficiency of the individual as an individual.

[*February* 26, 1934]

Ewing's Tumour (Endothelial Myeloma) of the Mandible: or Diffuse Myelosarcoma

By GEORGE T. HANKEY, L.R.C.P., M.R.C.S., L.D.S.E.

I AM showing this case for three reasons: (1) the extremely rare type of tumour; (2) the difficulty of diagnosis; (3) the strikingly rapid and fatal course of the disease.

The patient, Miss M. T., with dark complexion and hair, was aged 16 years and 10 months when she first attended as an out-patient, at the London Hospital on February 16, 1933.

She was a cheery, vivacious, well-developed girl, quite unaware that there was anything wrong with her beyond a sore gum, and only in attendance because her doctor had insisted that she came for advice.

History.—She visited her dental surgeon on November 25, 1932, after four days of tenderness and pain in the lower right first molar, and local external swelling of the gums, of one day's duration.

The tooth had a large filling in the crown. The swelling of the gum was smooth, tense and red. The tooth was extracted with difficulty under local anæsthesia, and the extraction was followed by considerable hæmorrhage, lasting twenty-four hours, and then by subsidence of the swelling. The dental surgeon states that, to his surprise, there was no suppuration or inflammation.

The extraction relieved the pain and tenderness, but three weeks later the patient noticed granulations growing from the socket, and the adjacent teeth became tender. At no time was there any discharge or other sign of suppuration.

The granular mass gradually crept forward along the buccal gum margin. The only local treatment received was a mouth-wash and antiphlogistine externally. On the whole there was very little disability. It was eleven weeks after the first symptoms in the mouth when she came to see me.

On examination.—Externally there was slight general puffiness of the right side of the face and a little swelling in the right molar region; no tenderness or inflammation; no enlarged glands. Inside the mouth, there was a soft, pink, granular mass, the same colour as the gum, growing from the $\overline{6}|$ socket and extending forwards buccally along the gum-edge as far as $\overline{2}|$. In the $\overline{32}|$ region the gum merely appeared hypertrophied. The $\overline{54}|$ were rather loose and periostitic.

Diagnosis.—Clinically I was unable to decide between a neoplasm or some unusual chronic inflammatory condition. I somehow leaned towards neoplasm and therefore took photographs, skiagrams, an impression and, lastly, a small piece of the growth for pathological examination. The report on this was, "Severe chronic inflammation of gum." The buccal sulcus was scarcely yet involved and the cheek was freely movable. The skiagrams revealed very little beyond rarefaction of the alveolar border and around the $6|$ socket, with marked periodontitis of $\overline{54}|$.

Further history.—I sent the patient away to await the report on the section. She failed to keep the next appointment. She had developed acute abdominal symptoms, had been taken into hospital, and had had her appendix removed by Mr. W. S. Perrin, March 1, 1933. The pathological report on the appendix was: "Submucous fibrosis and slight subacute inflammation." At this point, in the light of the subsequent history, I venture to suggest that the abdominal symptoms were probably coincident with the spread of the general disease in that region. I saw her in the ward a day or two later and at once noticed the rapid increase in the size of the external swelling, and of the tumour inside the mouth. The granular mass had crept round the gums as far as the $|\overline{3}$, also involving the buccal sulcus and binding the right cheek to the gum. In addition, a firm swelling had appeared in the right submental and submaxillary area, apparently attached to the jaw. There was very little pain or tenderness. She recovered uneventfully from the appendicectomy.

On March 10, 1933, Mr. Perrin removed as much of the growth as possible from the socket and sent it for microscopical examination. The report was: "Polygonal, spheroidal, undifferentiated, epidermoid-celled, medullary carcinoma of gum"—indicating the primitive type of cell and the extremely malignant nature of the neoplasm. The hard swelling below the mandible had increased rapidly, and had become tender and red below the chin. No fluctuation or pus. Skiagram (fig. 1) March 23, 1933: The tumour must have been present for four months.

On March 31, 1933, Mr. Perrin inserted 7×4 (0·6 milligrams) radium needles in the mass below the jaw. The needles were left in for four days, and the swelling rapidly subsided. The patient was discharged from hospital on April 6, 1933. There was still no clue as to the real nature of the disease, although the prognosis of the tumour diagnosed was bad.

On May 17, 1933, the patient was readmitted to hospital, on account of a hard tender swelling about 2 in. by $2\frac{1}{2}$ in. in the middle of the shaft of the left tibia. There was a little superficial inflammation, but this soon disappeared under local treatment. On inquiry it was then learned that about three weeks previous to the first dental symptoms, she had sustained a severe blow from a hockey stick on her left shin, where the swelling had now developed. The original bruise subsided after some time, though at intervals the area had become tender and a little swollen, but evidently the disability was so slight that she did not draw anybody's attention to

it, until a few weeks after the successful radium treatment of the jaw. The pain in the tibia then became so severe that she was readmitted on account of this, not because of the tumour of the mandible, of which, however, there were signs of an early recurrence, for the jaw was considerably thickened on the right side, with a small hard mass beneath and attached to the lower border.

The swelling of the tibia was diagnosed as a chronic osteomyelitis. The report on an X-ray examination on May 25, 1933, was: "Suggests periostitis." The swelling increased, and another report on June 13 (by Dr. G. E. Vilvandré) was: "Some changes of subcortical portion of the left tibia upper end. Rarefaction evident. Not yet typical of an abscess; no obvious regenerative change, but possibility of mild and early osteomyelitis. No chronic periostitis yet." On June 16 the swelling of the tibia was incised, and a considerable amount of granular tissue was removed and a portion sent for section. The pathological report was: "Myelo-

FIG. 1.—Ewing's tumour of the mandible, four months' duration, showing slight diffuse rarefaction of bone in the premolar and molar regions.

sarcoma, or Ewing's endothelial myeloma." We then compared the slides of the mandible with those of the tibia, and without doubt the structure of the two tumours was identical. The diagnosis was: "Ewing's diffuse endothelioma of bone" otherwise known as an endothelial myeloma or myelosarcoma. The wound of the leg healed up without trouble, but the remaining history of the patient is that of rapid dissemination of the neoplasm throughout the skeleton.

Blood examination 25.6.33: Normal. Urine: Bence-Jones albumin test 1.7.33, negative.

Radiological report 4.7.33 (Dr. Vilvandré).—"The left tibia shows a good deal of alteration in the subcortical portion. It looks as if the bone has been decalcified or, more likely, replaced by some softer, more penetrable tissue."

Deep X-ray treatment was given, but the patient rapidly lost weight, and became pyrexial and anæmic. The tumour of the mandible spread right round to the left

side, and involved the cheek, masseter, parotid, and floor of the mouth. She suffered acute agony from a tumour at the head of the left fibula involving the ham-strings and peroneal nerve. Nothing could give her relief except morphia. She died on 13.9.33 aged 17 years and 5 months. She spent the last two months of her life at home. Her medical attendant states that there were no signs of pulmonary metastases right up to the end—but there was no post-mortem examination.

Conclusion.—In this case, there seems no doubt that the trauma to the left tibia was the cause of the neoplasm—that the growth of the tibia was primary, while that of the mandible was secondary. The disease was fatal within eleven months. The diagnosis of this disease is unusually difficult, but fortunately the disease is equally rare.

Pathology of diffuse endothelial myeloma or myelosarcoma.—This neoplasm of bone is now almost better known as "Ewing's tumour," which in itself is a tribute to the great work which Ewing has done in describing and differentiating it from other neoplasms of bone. For pathological detail, I can do no better than refer my readers to his book "Neoplastic diseases" from which I have gleaned most of my information. The meningeal endothelioma, or brain tumour, has long been recognized, but there are also endotheliomata of nerve-trunks, and of serous membranes such as the pleura or peritoneum. The diffuse endothelial myeloma, however, is a definite clinical and pathological variety of endothelioma, as it affects bone.

Ætiology.—It arises from some type of endothelial cell of the bone-marrow; either (*a*) a primitive blood-forming cell of the reticulo-endothelial system (Connor, Turnbull, and Woods), or (*b*) a cell of the perivascular endothelium of angioblastic function (Ewing).

The reticulo-endothelial system seems the more likely. The inciting cause is usually infection or inflammation—less commonly, trauma. It is a disease of childhood, its malignancy decreasing in adults. It more commonly begins in the flat bones; next in frequency in the shafts of the long bones. Buccal or tonsillar infections have been observed before an outbreak. Syphilis or tuberculosis seem to have no connexion with it. Osteitis fibrosa has been found at the same time in unaffected bones. In some cases the blood-calcium has been found to be very low.

Clinical course.—There is a slow onset of mild pain and disability of one bone, with intermittent attacks of fever. As much as six months may elapse before a tumour is discovered: the tumour may grow and then subside, or may be rapid from the start. It is extremely osteolytic, resulting in spontaneous fractures. The fever, local heat, and X-ray appearances frequently lead to confusion with osteomyelitis. Secondaries in the skull are common—often an early clue. Pulmonary metastases only occur late in the course of the disease. The duration may be three months to three years. It is almost always fatal—but one case of a single tumour in an adult, treated by radiation, was followed by cure.

Gross anatomy.—The bone-marrow is cellular and opaque; the cancellous tissue is absorbed and honeycombed.

X-ray examination shows wide involvement of the shaft, as opposed to osteogenic sarcoma. There may be a little new bone laid down by the periosteum in parallel or irregular formation, but the periosteum is soon perforated, and the soft tissues are infiltrated or displaced. The tumours are very vascular and may vary in size, owing to a hæmorrhagic tendency and necrosis at their centres. The origin may be a multiple primary one throughout the reticulo-endothelial system and this may explain the mode of spread, which is otherwise unknown.

Microscopical anatomy.—Fig. 2 (p. 86) shows the section of gum under a $\frac{1}{3}$ lens magnified 75 times. Fig. 3 shows the gum, and fig. 4 the tibia, under a $\frac{1}{1\frac{1}{2}} \times 1200$. The formation and the structures of the cells in figs. 3 and 4 are identical; and upon this evidence the diagnosis of diffuse endothelial myeloma was made.

The usual formation, as in this case, is in sheets of polyhedral cells, without intercellular material. The cell-membrane is fairly well defined, with clear cytoplasm and well-staining vesicular nucleus, often hyperchromatic. The nucleus may contain many minute nucleoli, but acidophile nucleoli are absent.

Dissemination.—(*a*) by invasion of regional lymph-nodes, and cell emboli; or (*b*) by multiple primary growths. Secondaries usually appear a few months after the onset of the disease; first in the skull, then in the ribs, flat bones, vertebræ and long bones. Pulmonary metastases are late. In a late stage, nearly the whole marrow system is the seat of diffuse tumours, while the cancellous tissues are absorbed.

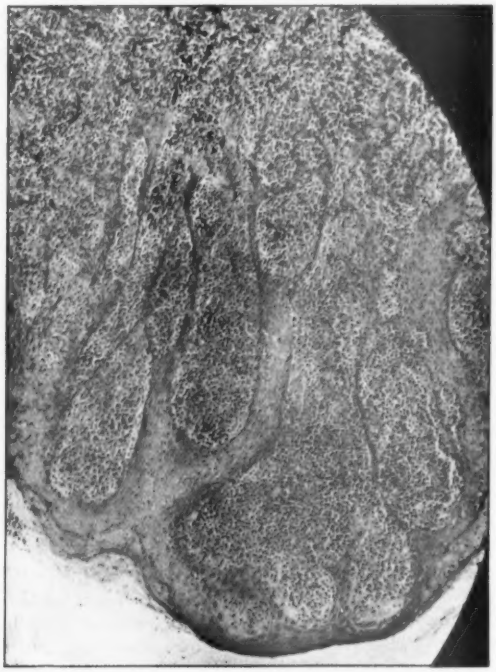

FIG. 2.—The gum on 10.3.33 under a $\frac{1}{3}$ lens × 75. Ewing's tumour.

Differentiation.—(*a*) from osteogenic sarcomas: In contrast; (1) the endothelial-myeloma is slower in onset, and the course of the disease is usually longer; (2) there is the initial intermittent swelling and fever; (3) the secondaries pre-select the bone-marrow; (4) the cells have a marked osteolytic property; (5) the lymph-nodes are invaded; (6) there is wide involvement of the shafts of the long bones; (7) there is an initial sharp response to radiation; (8) involvement of the lungs is late.

(*b*) From diffuse myeloma of bone which: (1) is composed of plasma cells and myeloblasts; (2) confines itself to bone-marrow; (3) is usually found in males over

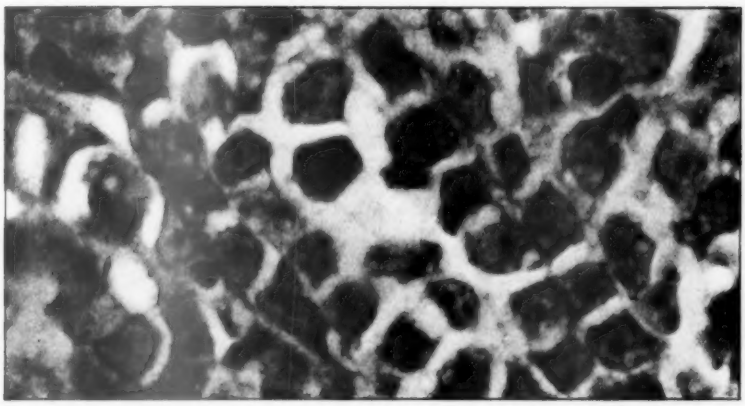

FIG. 3.—Gum on 10.3.33 under $\frac{1}{12}$ × 1,200. Ewing's tumour.

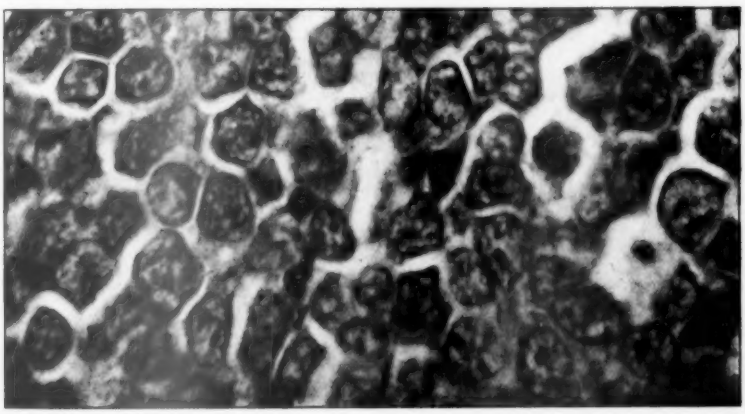

FIG. 4.—Tibia 16.6.33 under $\frac{1}{12}$ × 1,200. Ewing's tumour.

20 years of age; (4) has a rapidly progressive, and invariably fatal course; (5) often gives the Bence-Jones albumin reaction in urine.

Treatment.—(*a*) Radiation in full doses, over considerable periods: In some cases this has effected a rapid cure, in others, a disappearance for a time. The response to radiation confirms the diagnosis, as opposed to osteogenic sarcoma, and there is no danger of metastases during treatment, as the tumour liquefies and necroses.

(*b*) Local excision or amputation after radiation: The older the patient, the better the prognosis. In children, since recurrence is the rule, surgical interference seems to be contra-indicated.

Section of Ophthalmology

President—A. C. HUDSON, F.R.C.S.

[*February* 9, 1934]

Radium as an Adjuvant to Operation in a Case of Deformity of Eyelids from Burn with Keloid Scars.[1]—A. C. HUDSON (President).

B. S., male, aged 33.

History.—Burn of face from explosion of boiler behind furnace four years ago. Ectropion of both lids with keloid scars of cheek, and between eyelids and nose.

April 9, 1931: Thiersch graft to upper and lower eyelid.

May 5, 1931: Lower lid elevated by means of tongue-shaped flap from cheek. Thiersch graft to denuded area below flap.

November 9, 1931: Skin flap from forehead inserted in area of keloid formation between eyelids and nose. Contraction occurred at the base of the skin flap brought down at the last operation, causing it to assume an almost cylindrical shape. Consequent on radium treatment by Dr. Fildes this contraction has receded and the interpolated skin has become correspondingly flattened out.

Three radium treatments with 0·5 mm. platinum screenage were given, using 5 mgm. 1 in. active needles, with five needles for 30 minutes and 40 minutes on November 27 and December 2, 1931 respectively, and with six needles for 45 minutes on February 2, 1932.

Discussion.—The PRESIDENT said it was not very rare for burns to be followed by keloid formation between the side of the nose and the inner part of the lower lid. He would like to know whether in these cases it would be good treatment to give the keloid an exposure to radium, for weeks or months, before doing a plastic operation. His own view was that this might be desirable.

Another point of interest in this case was, that on one, and one only, of the several occasions on which a skin graft was taken from the arm, repair of the denuded area was associated with keloid formation. He was unable to say whether the graft was cut with the same knife as was used on the face.

Mr. JOHN FOSTER said that the general practice in cosmetic surgery of this area would be to get rid of as much fibrous tissue as possible before grafting. This would indicate that radium should be employed before operation, rather than after. This, however, might cause difficulty in that the tissues were devitalized for six weeks after exposure to radium, and a graft would not take, as he had found to his cost in attempting to graft a raw area left after an evisceration of the orbit which had been exposed to radium to prevent recurrence of a sarcoma. It might, therefore, be well to wait a few weeks after the radium treatment before grafting in the President's case.

[1] At a Joint Meeting with the Section of Dermatology. For report of papers and other cases see *Proceedings*, 1934, xxvii.

Metastatic Focal Choroiditis.—A. C. HUDSON, F.R.C.S.

V. C., male, aged 18.

History.—Dimness of sight of left eye (five weeks). Acne vulgaris of face and chest (one year). One lower molar tooth carious (about six months). Sachs-Georgi reaction negative.

Left vision with + 0·5D. cyl. 60° = $\frac{6}{6}$ partly.

Left eye: Patch of active choroido-retinitis about 3 disc diameters down and in from O.D. Cultures of pustules on cheek and neck yield pure growth of *Staphylococcus albus.*

Treatment.—Extraction of carious tooth.

Metastatic Focal Choroiditis.—A. C. HUDSON, F.R.C.S.

G. H., male, aged 29.

History.—September 9, 1920. Area of active choroido-retinitis adjoining lower inner margin of right O.D. History of boils on neck during the preceding two years. Some dental caries: no evidence of tuberculosis found. Wassermann reaction negative.

Six injections of a vaccine of *Staphylococcus aureus* obtained from pustules on the face were given.

Present condition: Right vision = $\frac{6}{6}$. Choroido-retinal scar at site of previous inflammation.

Plastic Operation.—JOHN FOSTER, F.R.C.S.

The patient is a woman, aged 48, who fell on to a fire during an epileptic attack on February 16, 1931. The left eyelids were completely everted, the eyelashes of the upper lid being situated in the normal position of the eyebrow. The eyebrows were destroyed, and all that remained of the right eye and lids was a shrunken globe and a flattened area of conjunctiva.

A circular incision was made around the lids of the left eye, fibrous tissue was dissected out, and the lids were freed, brought down to their normal position, and sutured together. The area was then covered by a Thiersch graft, moulded with stent. This "took" well on the upper lid, but was not very successful on the lower, on which the operation had to be repeated. An eyebrow was then grafted from the post-mastoid region by means of a whole skin-graft of the Wolfe type. The hairs from this have only grown at the outer and inner margin of the eyebrow, but the scar and small area of skin of a texture different from that remaining on the lids provides the face with some expression.

Loss of Accommodation for no Apparent Cause.—JOHN ATTLEE, M.D.

Jean P., aged 16. Towards the end of November 1933, gradually lost all power of accommodation, and when seen on November 29, 1933, was unable to read quite large print, the pupils were widely dilated, reacting sluggishly and only slightly to light.

Vision: Right eye: $\frac{6}{9}$, with − 0·5D. spherical = $\frac{6}{6}$; left eye: $\frac{6}{9}$, with − 0·5D. spherical = $\frac{6}{6}$ partly. Both fundi were normal. No heterophoria. All reflexes were normal. The patient had binocular vision. She could read Jaeger 1 perfectly right and left with + 3D. spherical.

The urine was normal. Chicken-pox developed twelve days afterwards.

No liniments or ointments containing belladonna or atropine had been used for any purpose. There was no history of sore throat or cold. Swabs from nose, nasopharynx and throat were all negative.

The pupils are now much smaller, reacting to light much better, and the accommodation is gradually returning. She can read somewhat small print for a minute or so, and then is obliged to resort to the glasses again.

Two Familial Groups of the Laurence-Moon-Biedl Syndrome—T. R. HILL, M.D., M.R.C.P. and ARNOLD SORSBY, M.D., F.R.C.S.

Group I.—This family, born of healthy, non-consanguineous parents, consists of nine members. Three are affected. The affected members (female, aged 27; male, aged 23; male, aged 17) show in common (*a*) retinitis pigmentosa; (*b*) mental deficiency.

In addition: Female, aged 27, shows moderate adiposity; male, aged 23, shows the complete Fröhlich syndrome (dystrophia adiposo-genitalis); male, aged 16, shows a scar on the ulnar side of the left hand, indicating the site where a supernumerary digit was amputated.

Group II.—This family—also born of healthy, non-consanguineous parents—consisted of four members. One, said to have been normal in external appearance, died in infancy. The three surviving children are affected. The eldest, male, aged 16, is an inmate of a home for the mentally deficient. He is blind and has polydactyly. The two younger children (female, aged 13; female, aged 9) both show (*a*) mental deficiency; (*b*) macular dystrophy; (*c*) adiposity.

In addition: Female, aged 13, shows scars on ulnar side of hands at site of removal of supernumerary digits and also six toes on each foot.

Female, aged 9, shows scars on hands at site of amputated supernumerary digits.

[*June* 8.]

Metastatic Hypernephroma of Iris

By A. C. HUDSON, F.R.C.S. (President), and Sir WILLIAM LISTER, K.C.M.G., F.R.C.S.

THE rarity of involvement of the iris by a metastatic tumour may be estimated from the fact that we have been able to find records of only 17 cases. In 15 of these the primary growth was a carcinoma, in one a pigmented nævus of skin (ten Doesschate), and in one a hypernephroma, of which the following case is a second example:—

The patient, a man aged about 55, had noticed, three days before excision of the right eye by one of us (W. T. L.), a peculiarity in its appearance due to the presence of a yellowish-white swelling with blood-vessels on its surface, which involved the upper third of the pupillary portion of the iris. The swelling was composed of a row of three equal-sized nodules in the substance of the iris, the free border, which encroached slightly on the pupillary area, having a crenated outline. The eye was free from injection and vision was $\frac{6}{6}$. The left eye was normal.

There was some pleural friction at the right base, but no sign of infiltration of the lung, and no evidence of tuberculosis.

One kidney had been removed by Mr. Hurry Fenwick two years previously, and found to contain an encapsulated malignant tumour which had ulcerated into the renal pelvis. We have been unable to obtain information as to the histological characteristics of the tumour.

The eye was fixed in Zenker's fluid followed by salt formalin, and divided sagittally through the outer part of the tumour.

Macroscopical examination.—All the structures appear normal except the iris, the pupillary portion of which is involved by a swelling which measures about 1·5 mm. antero-posteriorly and 4·5 mm. from above downwards.

Microscopical examination.—The thickening of the iris is due mainly to infiltration with neoplastic cells which have caused widespread disorganization, very evident in the case of the sphincter iridis muscle and the tissues in the neighbourhood of the anterior and posterior surfaces. Anteriorly the cells have formed, on the broken surface, a solid mass completely devoid of blood-vessels; posteriorly, they have disorganized the posterior border lamella and the anterior layer of pigment cells, and project into a cystic space bounded posteriorly by the intact posterior pigment layer (figs. 1 and 2). The great majority of the cells of the new growth are large, with a small nucleus, somewhat angular in outline, and displaced towards the periphery of the cell, the cytoplasm of which is either scanty, and faintly staining, or entirely absent, so that the cells present an appearance of more or less extreme vacuolation. Very rarely smaller cells with a central round nucleus and well-stained cytoplasm are visible. Some of the cells at the deepest level of the cell-mass on the anterior surface of the iris are much elongated and are arranged in palisade formation at right angles to the surface, others, where they form a single layer on the surface, are of columnar shape: elsewhere the cells are for the most part polyhedral from mutual pressure (fig. 3). Dr. Marian Watson has kindly stained a section for glycogen and demonstrated its presence in fairly large quantity in the tumour cells. At no point is there any indication of alveolar or acinous arrangement of the cells, and there are no blood channels of tumour formation, but the iris vessels in the central part of the involved area are abnormally abundant, and in some cases of huge calibre. The iris beyond the tumour shows some round-celled infiltration, but is otherwise normal.

From the character and arrangement of the cells, and the history of the case, there can be little doubt as to the origin of the tumour from a hypernephroma of the kidney, and this view has the support of Dr. P. N. Panton, who has examined sections.

The only other reported case of the kind is that of Burton Chance, in which the ciliary body was involved as well as the iris; there were also nodules of new growth in the skin, and at the post-mortem examination others were found in the mesentery in addition to the kidney tumour. Signs of iridocyclitis were present in this case, and have also been noted in cases of involvement of iris and ciliary body by metastatic carcinoma (Uhthoff and von Hippel), a complication liable to suggest an erroneous diagnosis of tuberculosis or syphilis.

Hypernephroma metastasis involving the choroid has been recorded by Kreibig, Beatson Hird, Small, and Stock.

In many of the comparatively common cases of adrenal tumour, metastasis implicating the orbit the new growth has been found to have the character of a neuroblastoma of medullary origin. Such tumours have no histological affinity to the tumour in our case: for the purpose of comparison a section of one of them, kindly lent by Mr. F. W. Law, is shown.

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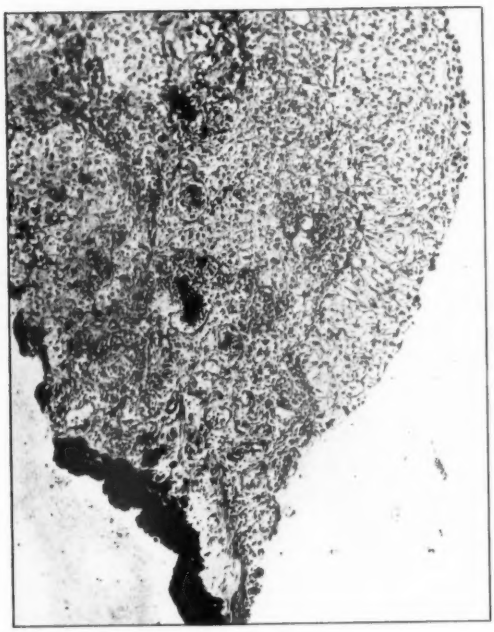
PLATE I

× 16

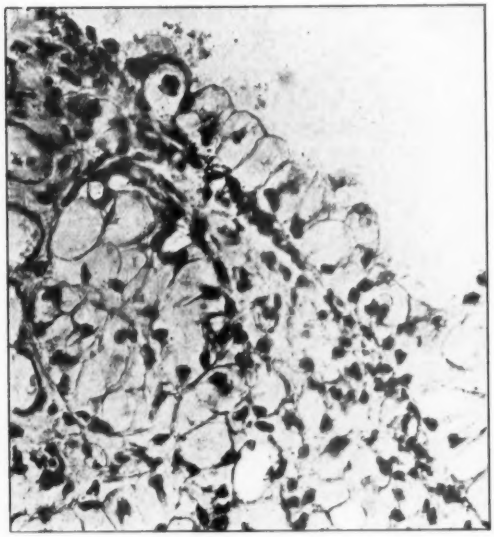
FIG. 1

PLATE II



× 62

FIG. 2



× 250

FIG. 3

HUDSON and LISTER : Metastatic Hypernephroma of Iris.

Sir WILLIAM LISTER: The patient came to me in August 1911 for a third opinion, and I found the kidney-shaped new growth which the President has described.

It was decided that this mass was probably a carcinoma and the eye was removed without delay. I heard after that the patient did not live for more than two years—probably for less—after the operation, and died of a tumour of the brain.

The Significance of False Projection on Squint

By M. A. PUGH, L.R.C.P., M.R.C.S.

Binocular vision.—When one eye deviates, diplopia tends to be produced, and in a large number of cases the history of transient diplopia on the onset of squint can be obtained. In some cases this diplopia persists and the patient does not succeed in either overcoming or evading this difficulty.

It may be evaded by suppressing the image of one eye by mental process. Such eyes retain true projection. Diplopia may be overcome by a mental reorientation of the displaced image, which image is now localized in space in a position corresponding to that of the fixing eye. This is known as false localization, and like the alternative suppression, is a mental process.

(1) Suppression of an image prevents the confusion arising from diplopia. One eye alone may be suppressed, as in a constant monocular squint. Alternating suppression may occur, either eye being fixed whilst its partner suppresses. Such a squint would fall into the alternating group since the vision of neither eye deteriorates.

(2) The second method of dealing with diplopia when it is not accepted, is to develop false projection, so that the images which would be seen apart, owing to the deviation of the visual axes, are projected in space so that they fuse.

In this second method suppression may be used but it is not total suppression; both eyes accept the images presented to them, but suppress in certain parts of the field, just as in true projection the suppression may occur when an image is presented to each macula at the same time.

In dealing with 400 cases, it was found that 169 cases (42¼%) had false projection, and 226 cases (56¼%) had true projection. There is, however, a margin of error in the estimation, owing to the fact that squinters are often treated by occlusion before the degree of binocular vision is measured, and therefore may not be in their initial stage of projection, also that the monocular squints which tend to have true projection are sent for treatment early and more consistently because the amblyopia causes anxiety. The third source of error is that the test is a subjective one; children who are seen at an early age give unreliable answers. Taking these points into consideration, it is perhaps fair to estimate that about 50% of squinting eyes develop false projection. To analyse the group of false projection further gives the result that 73% were alternating squinters and 37% unilateral squinters. The analysis of true projection cases showed 83% unilateral squints, and 17% alternating squints. In other words of all alternating squinters 77¼% have false projection and of all unilateral squinters 83% have true projection. It should be explained that the term alternating squinters has been applied to the group which includes the true alternators from onset and also cases of acquired alternation where the vision has remained the same for a year or more without any occlusion.

The difference between the true and acquired alternation does not lead to any consistent difference in binocular vision, since the alternator from onset may have true projection as tested on an amblyoscope, and will suppress the second image entirely under normal conditions, or a similar case may use a false projection.

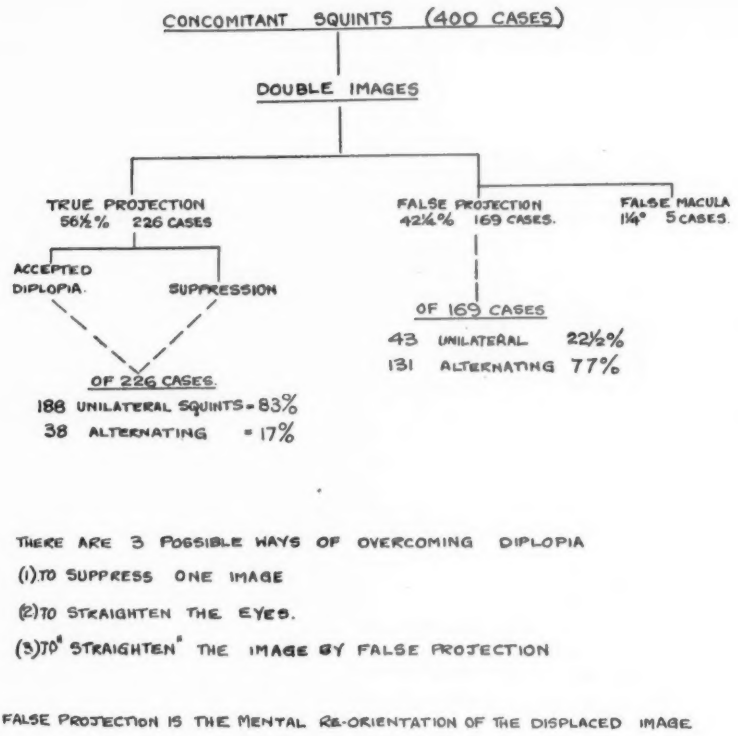


CHART A.

The comparison of binocular vision by true projection and binocular vision by false projection.—True binocular vision is generally graded into Worth's three grades: (1) Simultaneous macular perception; (2) Fusion with some amplitude; (3) Depth perception. Binocular vision by false projection falls into much the same grouping. The bird may be put in the cage as in Grade 1 vision, one difference being that the angle at which the images are superimposed is not at the angle of squint.

The more developed case of false projection will "fuse" similar images again at an angle other than the true deviation and have an amplitude of the "fusion." In a few cases the technique of binocular vision is developed to give a pseudo Grade 3 vision; by quick alternation some depth value is obtained, though never complete stereoscopic vision. Just as a lateral false projection makes fusion possible, so when there is a vertical deviation, a vertical false projection may be developed in order that fusion can occur.

In such cases where desire for binocular vision is great enough to cause the development of a vertical false projection, but where the deviation is sufficiently large to make this difficult, the patient may develop an ocular torticollis. To put it the other way, most cases with an ocular torticollis will show an effort to develop a vertical false projection.

As in cases of true projection moments of diplopia may occur in cases which usually suppress, so in binocular vision by false projection, suppression may occur. A patient may complain of diplopia which is due to true projection, although his usual habit may be to fuse by false projection.

Comparison of false projection and false macula.—In five cases ($1\frac{1}{4}\%$) when the good eye was covered, the squinting eye fixed with eccentric fixation, and on further examination the vision at the macula was found to be less than the vision at the fixing spot of retina. In this case it is fair to say that the eye has developed a false macula though in no case has the vision at the spot developed to more than $\frac{6}{24}$ths. Occlusion does nothing more than stabilize the eccentric fixation, no response being obtained by stimulation of the macula. Such a case differs from the amblyopic eye which, although the vision may be reduced to $\frac{1}{60}$th will on occlusion fix centrally, and macula vision is developed. It is possible that the macula is anatomically displaced or congenitally defective in these cases, but we have no evidence of this as yet. It is a definite group which should not be confused with false projection.

Significance of false projection with regard to operative results.—If a patient's eyes are straightened by operation while he is still using false projection, he may after operation do one of three things.

(*a*) He may, finding the visual axis parallel, develop a true projection and fuse with his eyes straight.

(*b*) He may pass through a transitional stage when he learns to readjust his projection so that he eventually adapts himself to the new position of the eyes. During this transition there is a false diplopia, in other words, a diplopia due not to faulty position of the eyes but to faulty projection of the visual images in space. He attempts to fuse the images with a false projection, and before the new projection is developed there is a tendency to recover some of the original deviation.

(*c*) He may show no sign of modifying his false projection, but retains it. Such a patient suffers from a troublesome false diplopia and in his efforts to overcome this symptom he reverts more or less to his original deviation.

In conclusion, we must emphasize the difference which exists in the capacity to identify an image which we commonly call visual acuity, and the capacity to localize that image either with one or with both eyes. The former function, except in rare cases—less than 1% of all squints—is best developed at the true macula. Normally, the macula is also the localizing spot, that is, if the visual axes are parallel the maculæ are corresponding points. If, however, the axes are not parallel the corresponding point will be the macula in the fixing eye, and the new localizing spot corresponding to it in the squinting eye. In binocular vision it is this spot which is used in conjunction with the opposite macula for localizing in cases of false projection. These facts afford a basis for considering and explaining the following observations which may be made in cases showing false projection :—

Case I.—O. F., aged 11. R. V. $\frac{+3{\cdot}0}{+0{\cdot}5/_{30}} = \frac{6}{6}$ p. L. V. $\frac{+3{\cdot}0}{+0{\cdot}50/_{20}} = \frac{6}{6}$

12.9.33 : This patient had developed an alternating squint when aged 5, after starting school. On investigation, the squint was found to be 40° D. convergent whichever eye fixed. When tested for binocular vision it was found that although the eyes remained at a constant convergence of 40°D. it was necessary to move the arms of the amblyoscope so that each picture was at zero before the patient said that the bird was in the cage. The same result was obtained whichever eye fixed and when the patient was allowed to alternate fixation.

31.10.33 : Right advancement of external rectus and recession of internal rectus.

7.11.33 : The eyes were straight, no deviation of the visual axes being present in any direction. When tested for binocular vision it was necessary to move the

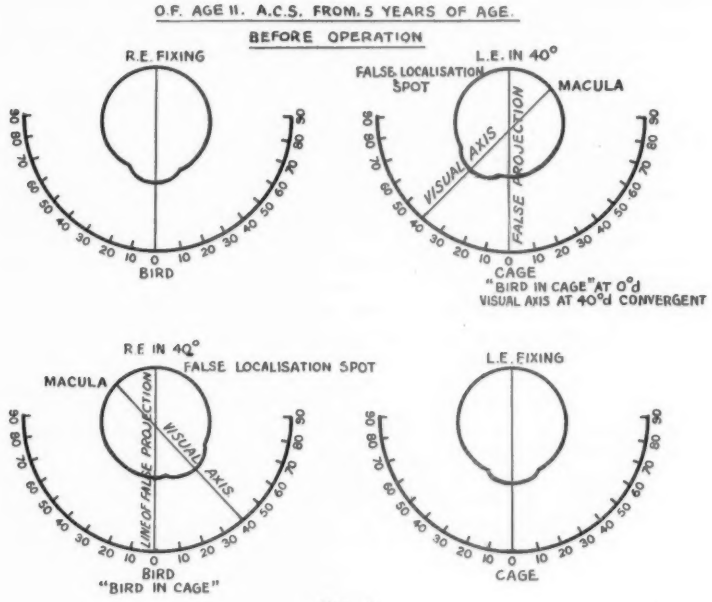

O.F. AGE 11. A.C.S. FROM 5 YEARS OF AGE.
BEFORE OPERATION
R.E. FIXING
BIRD
L.E. IN 40°
FALSE LOCALISATION SPOT
MACULA
VISUAL AXIS
FALSE PROJECTION
CAGE
"BIRD IN CAGE" AT 0°d
VISUAL AXIS AT 40°d CONVERGENT
R.E IN 40°
MACULA
FALSE LOCALISATION SPOT
LINE OF FALSE PROJECTION
VISUAL AXIS
BIRD
"BIRD IN CAGE"
L.E. FIXING
CAGE

FIG. 1A.

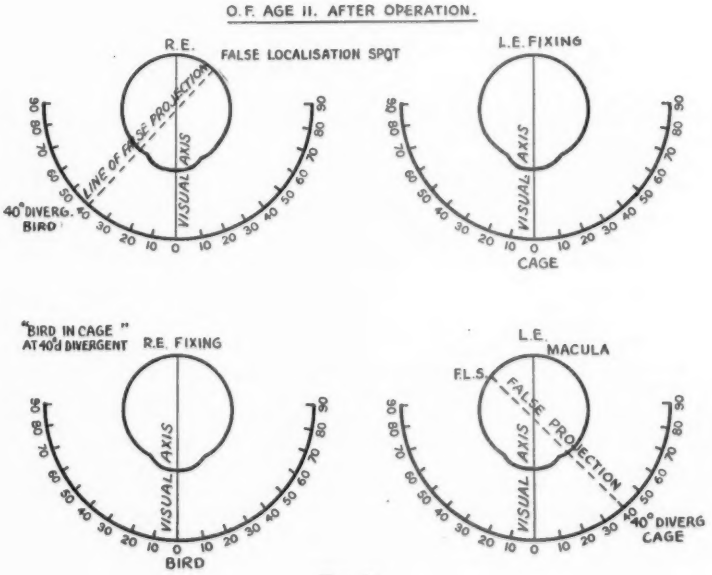

O.F. AGE 11. AFTER OPERATION.
R.E.
FALSE LOCALISATION SPOT
LINE OF FALSE PROJECTION
VISUAL AXIS
40°DIVERG. BIRD
L.E. FIXING
VISUAL AXIS
CAGE
"BIRD IN CAGE" AT 40°d DIVERGENT
R.E. FIXING
VISUAL AXIS
BIRD
L.E.
MACULA
F.L.S.
FALSE PROJECTION
VISUAL AXIS
40° DIVERG CAGE

FIG. 1B.

amblyoscope pictures to a position of 40°D. divergent before the patient saw the bird in the cage.

Conclusion.—It is thus seen that before operation the patient had learnt to allow for his deviation and to fuse his images in space as if his eyes were straight, having developed a false projection of 40°D. After operation, when the eyes were straight, he still maintained the same degree of false projection and projected his images 40°D. divergent to each other. He always fixed with the macula of each eye and used the false localization spot for localizing only.

Case II.—K. H., aged 17. R. V. $\frac{6}{5}$ emmetropic. L. V. $\frac{6}{5}$ emmetropic.

This patient had had an alternating convergent concomitant squint since she was 5 years old. The deviation was a constant 20° D. of convergence whichever

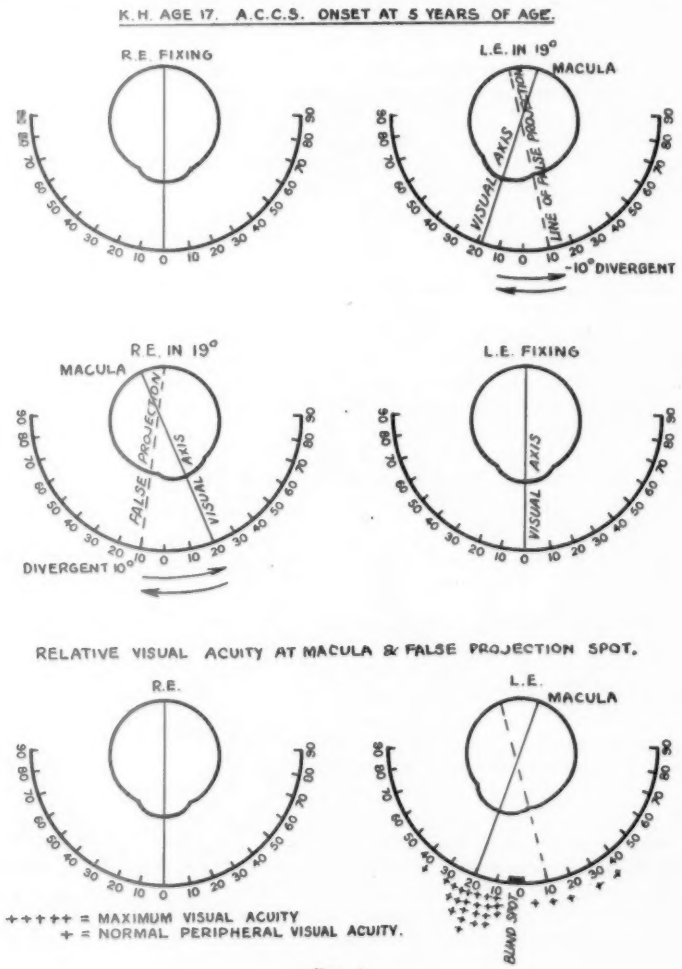


FIG. 2.

eye fixed. On testing the binocular vision it was found that she alternated from true to false projection according to the direction of movement of an image across her retina. Thus on an amblyoscope when the right eye was fixing the cage and the left eye was 20° D. convergent it was found that if the cage was moved in the field of vision from the periphery to the macula it was located with a true projection, the pictures being coincident at 20° D. convergent. When the cage was moved in the direction of periphery from the macula a false localization was used so that the pictures were said to cross at 10° D. divergent. The same answers were given when the left eye fixed and the right eye converged.

When the relative visual acuity of this area of retina was investigated it was found that the macula had the highest degree and that the false localization spot had no higher acuity than was normal for that portion of the retina. There was, however, a difference in that the band between these two points (nasal side of macula) appeared to be more sensitized than a corresponding area on the temporal side of the macula.

Conclusion.—This patient appeared to use a true projection when an object moved from the monocular field to the binocular field and to revert to a false projection when the movement of the object was from the binocular fields to the monocular field. The false localization spot had no increase in visual acuity but the band connecting this spot with the macula appeared to have become slightly more highly sensitized than normal retina in this position.

Case III.—E. S., aged 23. R. V. $+ 3{\cdot}0 = \frac{6}{5}$ L. V. $\frac{+ 2{\cdot}5}{+ 0{\cdot}5/90} = \frac{6}{60}$

This patient had a left convergent concomitant squint since she was 5 years of age. The left eye was 20° D. convergent before operation.

1.12.33 : Advancement of external rectus and tenotomy internal rectus.

11.12.33 : The right eye now diverged 7° but the amblyoscope pictures had to be placed at 23° D. divergent before the bird appeared to be in the cage. The patient complained of distressing diplopia and turned her eye in at times to about 20° D. convergent to overcome the giddiness.

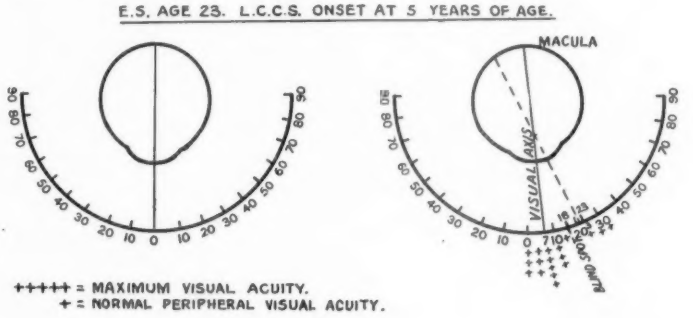

E.S. AGE 23. L.C.C.S. ONSET AT 5 YEARS OF AGE.
MACULA
VISUAL AXIS
BLIND SPOT
+++++ = MAXIMUM VISUAL ACUITY.
+ = NORMAL PERIPHERAL VISUAL ACUITY.

FIG. 3.

The relative visual acuity was investigated and it was found that although the vision at the macula was only $\frac{6}{60}$ there was no increase of visual acuity at the false localization spot.

Conclusion.—This is a patient who has an amblyopic eye due to a constant monocular squint and who attains some binocular vision by false projection but in whose case there has been no attempt to develop a false macula.

Case IV.—R.V. $\frac{+1{\cdot}0}{+0{\cdot}5-0} = \frac{6}{6}$ p. L.V. + 1·0D. = $\frac{6}{6}$

W. B., aged 29.

This patient, developed a right convergent squint at 3 years of age. This later became alternating without treatment. Before operation he had an alternating convergent squint of 25° D. His binocular vision was not investigated.

14.7.33 : Right advancement external rectus, tenotomy of internal rectus.

22.8.33 : Left recession internal rectus.

28.8.33 : Residual convergence 5° D.

Bird seen in cage at 25° D. divergent (on amblyoscope) by using false projection.

28.9.33 : Convergence 8° D.

Bird in cage at 10° D. divergent on amblyoscope using false projection.

26.10.33 : Convergence 18° D.

False projection indefinite. An effort was made to fuse around zero on the amblyoscope.

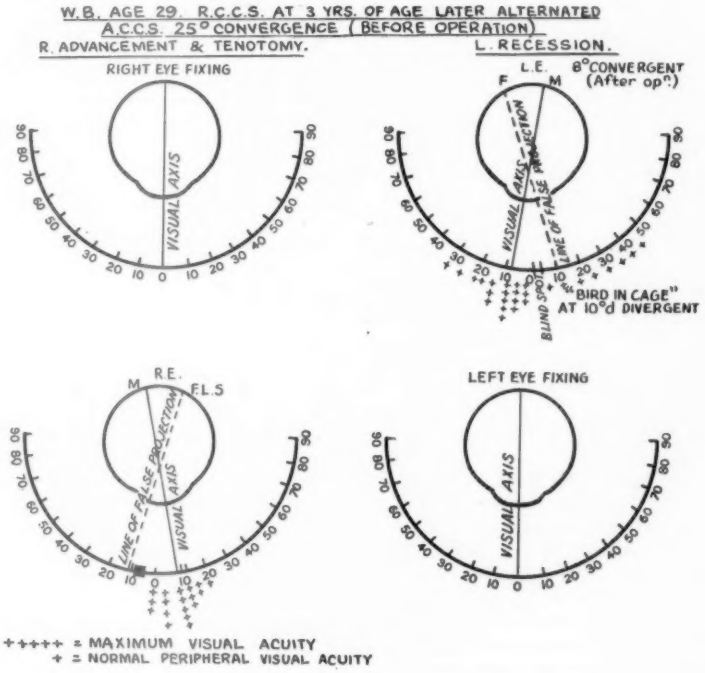


FIG. 4.

Conclusion.—This patient lived out of London and was unable to do the necessary training to break his false projection. His convergence increased from 5° D. to 18° D. in two months. According to the records of his binocular vision, it seems that this increase of convergence was probably due to the effort made to fuse the images with the false projection to which he had become accustomed.

I wish to thank the surgeons at the Royal London Ophthalmic Hospital for their kindness in allowing me to use their cases.

Mr. E. B. ALABASTER said that Miss Pugh had mentioned a false macula; he (the speaker) did not believe that such a thing existed. Further, he was becoming a little sceptical of false projection.

In a paralytic squint due to a paralysis of the right external rectus, one obtained false projection to the right on attempting to look in that direction. Similar images thrown on to the maculæ, however, would be fused. The brain commanded the eyes to look in a certain direction, and so far as it was aware they were doing so. Macular images, therefore, could be fused.

In concomitant squint conditions were different. The brain was aware, because the muscular sense was intact, that the faulty eye was converging. When similar images were thrown on the maculæ, that of the faulty eye was projected in the direction in which the eye was felt to be looking. This had been called false projection, but in reality was true. The proof of this lay in the unpaired temporal portion of the field of the squinting eye. So long as the squint was under 42 degrees the unpaired field would be present, and in it projection was always accurate, excepting after an operation. Since the temporal projection was accurate the macular projection must also be accurate.

In treating a concomitant squint by orthoptic methods, the first thing to do after overcoming suppression was to encourage relaxation of all active convergence. When this was accomplished, the eye had the same feelings in its muscles as though it were straight and looking in the same direction as the fellow eye. Under these circumstances the need for suppression was absent, and similar images on the maculæ might be fused.

The importance of this in operation could be easily understood. If the awareness of convergence was not abolished before operation it might persist after the eyes were put straight and effectively prevent any improvement of vision after the operation had taken place.

"Amber-bead" Cataract.—D. V. GIRI.

(*With coloured plate*)

Mrs. L. G., aged 64.

This patient has been under observation at the Royal Eye Hospital, Eastbourne, since November 1924, when fairly dense central nuclear opacities were noted in the right lens, by Mr. G. B. Lowe. She was first seen by me in September 1926, and the cataract was then nearly complete, showing dim red reflex peripherally, and looking like the usual senile cataract. In January 1928, it had become dark brown, and there was still very dim red reflex peripherally.

In October 1931, the cataract had turned orange-brown with dense white spots which could be seen under loop magnification; there was still faint peripheral red reflex. In April 1933, the cataract looked slightly brown, and the capsule dense, and an irregularly outlined white patch in the pupillary area was noted. In May 1933, the lens gave a deep orange reflex, and biomicroscopy revealed orange-yellow globules with a circumferential ring of greater translucency, the white patch in the centre persisting (see plate). On April 30, 1934, except for the lens and the globules having become amber in colour, there was nothing new to note.

The cataract in the left eye, on which a successful operation was performed in February 1928, had the usual appearance of a senile cataract. The fall of the vision in the right eye has been very gradual, and on May 28, 1934, the vision was noted to be $\frac{3}{60}$. The central and peripheral projection has been good all the time. The patient's general condition is apparently good.

This is the first case of the kind that has come under my observation. The condition is probably very rare. I have not found anything corresponding to it in Vogt's exhaustive "Lehrbuch und Atlas der Spaltlampenmikroscopie des lebenden Auges" or in A. Meesman's "Die Mikroscopie des lebenden Auges mit Spaltlampen-Atlas."

Has the peculiar discoloration and vacuolation of the lens any pathological significance? Is it a contra-indication to operation?

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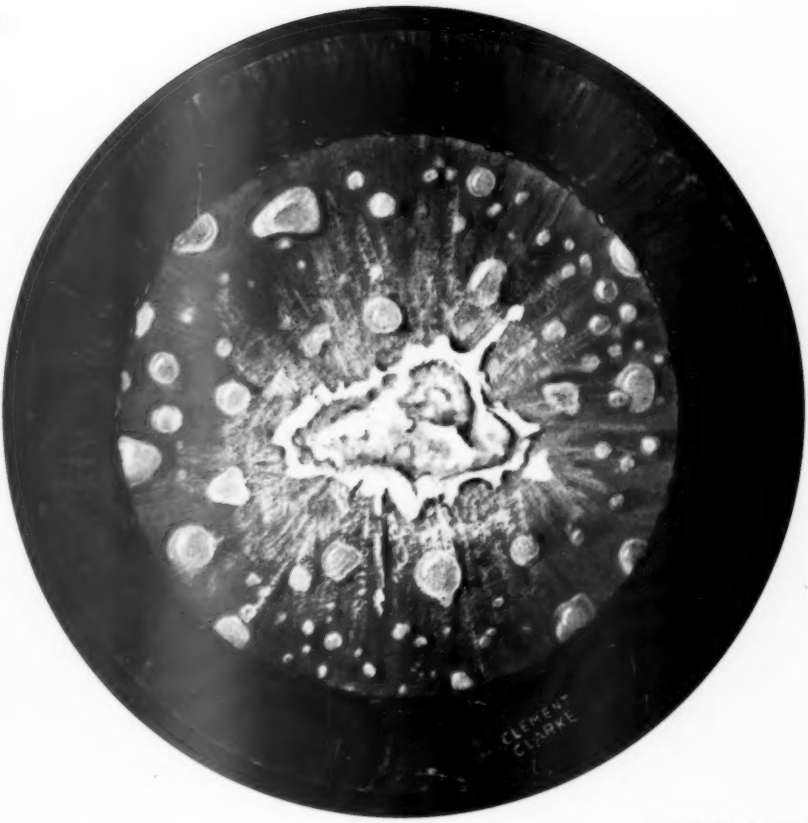


John Bale Sons & Danielsson, Ltd London.

GIRI : " Amber-bead " Cataract.

UNIV. OF MICH.

If operation were performed, what operative and post-operative complications are likely to occur?

Discussion.—Mr. LINDSAY REA said that the lens in this case was very dark brown, and appeared certainly to cause discoloration of the familial spots which usually appeared blue. The trouble he had had with these cases was with the capsular plaque on the surface of the lens. It was extremely difficult to prevent it floating up before the pupil, after the cataract had been extracted.

Mr. GRAY CLEGG said he thought that the best method of extraction in this case was to use the cystotome in a circular fashion, isolating the thick central capsule and drawing it out by forceps, then proceeding in the ordinary way. Probably by such manipulation the lens would come out quite easily.

Chronic Follicular Hypertrophy of the Conjunctiva.—EUGENE WOLFF, F.R.C.S.

Miss G., aged 18.

History.—Condition present nine months.

Right lower palpebral conjunctiva so swollen that the lid is kept away from the globe. Enlarged follicles in both upper fornices. No discharge. No pannus and no symptoms except some slight irritation last summer. No eosinophilia in conjunctival smear. Some increase of lymphocytes in the blood. No enlargement of spleen or other lymphatic structures.

A microscopic section shows the conjunctiva greatly distended with cells which are almost entirely lymphocytes.

The diagnoses of spring catarrh and trachoma were considered but the condition is typical of neither of these. The microscopic section, one would think, ruled out tuberculosis.

Superficial Corneal Opacities.—FRANCIS E. PRESTON, D.O.M.S.

This girl, aged 15, was seen by me on March 7, 1934. Both corneæ presented lesions which were superficial and apparently solid. The elevations were white and were confined to the central parts of the corneæ and had almost the appearance of tiny pieces of putty. I was then inclined to regard the condition as an unusual form of epithelial dystrophy.

When I saw her again on May 4 the appearance had changed. Most of the putty-like elevations had disappeared, and there were innumerable spots all over the corneæ with, apparently, a coalescence of the spots on the central portion of the right cornea, producing a haze, somewhat triangular in shape. The vision was $\frac{6}{24}$ with each eye and was not improved by glasses.

Family history.—The mother had two brothers who were deaf. She had four children by her first husband, three of whom are alive, the patient being the youngest. By her second husband she has had one child, now aged 12 years, and five years ago she had a miscarriage.

In the mother's opinion the patient's sight has never been good, and it has become worse lately, but she has never noticed anything wrong with the eyes except a little redness during her periods. Her skin has always been dry, and she is rather deaf and very timid. Owing to heart trouble she has not attended school regularly, and is backward at her lessons. She has always refused to eat fats, but lately has commenced to take butter.

Wassermann reaction negative.

Postscript (28.9.34).—On July 9 I prescribed halibut oil and the vision has now improved to $\frac{6}{12}$; the corneal haze has almost disappeared.

Herpes Zoster Ophthalmicus.—HUMPHREY NEAME, F.R.C.S.

R. K., a woman aged 64, was in hospital at Rochford for four months from November 1933.

Two weeks previously pain in the face had preceded spots on the forehead. Uncertain as to date of onset of eye symptoms.

Present condition.—Scars on left side of forehead and scalp. No scars on nose, but skin on left side very tender. Ciliary injection. Corneal nebulæ multiple. Two white spots near pupil margin on iris at 7 o'clock. Microscope shows corneal nebulæ superficial, involving not more than one-third of the thickness of the substantia propria at the most, with slight unevenness of the epithelium. Pigmented keratitis punctata. The two white spots in the iris show complete loss of pigment with change of pattern, presumed to be new fibrous tissue. Surrounding stroma healthy.

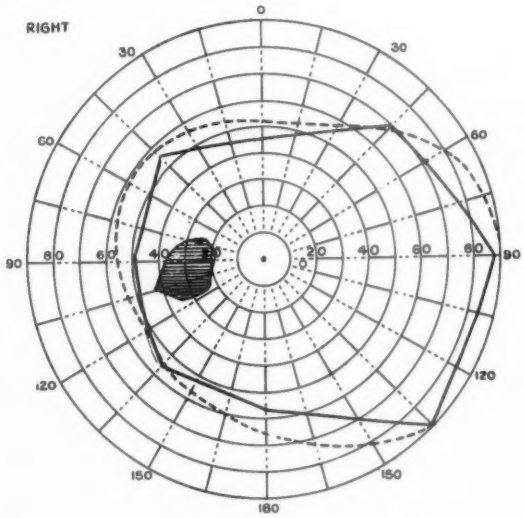
Mass Protruding in Vitreous of Right Eye. Case for Diagnosis. HUMPHREY NEAME, F.R.C.S.

Walter L., aged 30.

17.3.34: Failing vision in right eye for three weeks.

Right vision $\frac{-1{\cdot}0}{+0{\cdot}5/_{90}} = \frac{6}{18}$ Left vision $\frac{6}{6}$

A mass, conical in shape, protrudes forwards in the temporal region of the right fundus, with an orange-coloured patch on its summit, and two areas of superficial pigment on its lower surface. Projection of summit about $3\frac{1}{2}$ dioptres. Vitreous opacities moderate.



6.6.34: Summit of swelling about 4 dioptres. The retina to the side of the mass seems raised up.

Visual field.—1° white object shows a scotoma extending from the 20° to the 40° circle in the left field. (*See* Chart.)

Mr. D. V. GIRI said that there appeared to him to be some crystalline formation inside the bleb formed, which made him think that it was probably the result of hæmorrhage that had become absorbed and had destroyed the retinal elements.

True Distension Cyst of Meibomian Duct.—P. McG. MOFFATT, M.D.

Nellie B., aged 26.

Attended the out-patient department of the Royal Westminster Ophthalmic Hospital on account of a small swelling on the right lower eyelid. This had been present since she was 4 years old, and her mother, who noticed it then for the first time, took her to a hospital for treatment. A diagnosis of "granulation of the lower fornix," was made, and treatment in the form of lotion and drops was ordered. After some months no alteration was noticed in the condition and as the swelling was small and caused no trouble, all treatment was stopped. About six months before attending hospital, i.e. after a period of twenty-two years, the patient began to complain of slight irritation, and she thought that the lid looked swollen on the outside, as also did some of her friends. The irritation gradually became more accentuated, and she became anxious about the swelling. She then came up to the hospital for further advice.

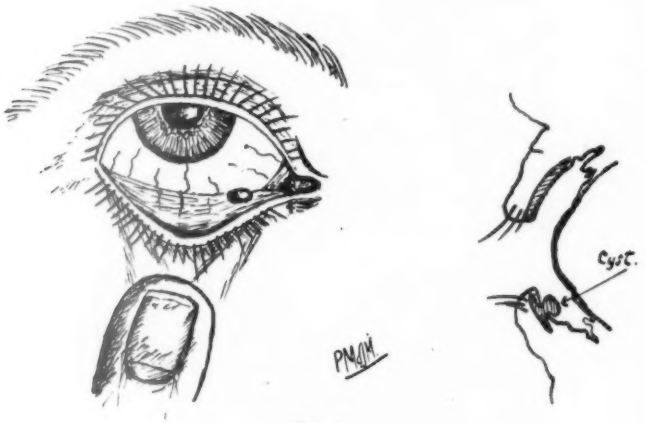


FIG. 1.

No history of injury or of acute or chronic inflammation of the eyes could be obtained, but just before the swelling was first noticed, she had suffered from an attack of pneumonia following measles.

On examination.—The right lower lid presented a slight fullness over the inner third, but on palpation there was no feeling of a hard lump. The eye otherwise presented a normal appearance.

On eversion of the lower lid a small red pedunculated swelling was seen on the palpebral conjunctiva. The appearances suggested a granuloma, such as might follow rupture of a chalazion. The situation of the swelling is indicated in the sketch (fig. 1).

The swelling was excised under cocaine. The peduncle was cut across at its attachment to the tarsal plate, leaving a small wound which healed in four days.

In view of the very long history, during which one would have supposed that a granuloma would have disappeared by cicatricial strangulation at its base, other diagnoses were considered. The specimen was therefore submitted for microscopical examination.

Mr. Eugene Wolff's report was as follows:—

"This is a true distension cyst of the meibomian duct. It is lined by flattened cells like those of a normal duct, and opening into it are the acini of the meibomian gland. It contains what are probably the débris of cells and sebaceous material. Around the cyst there is some leucocytic infiltration, and at one spot a mass of sweat-glands (glands of Moll)" (fig. 2).

FIG. 2.—Section of true distension cyst of meibomian duct.

I have been unable to find a report of a case of true distension cyst of a meibomian duct, but mention is made of these cysts in the literature as being of extremely rare occurrence. An illustration resembling this section very closely is to be found in Hencke Lubarsche "System of Pathology" in which the cause is regarded as congenital.

They are described as occurring most frequently after injuries, cicatrization following chronic inflammation of the lids and operative procedures, e.g. Burow's operation for cicatricial entropion, but in any case are not common.

The condition arising spontaneously must be very rare. The initial cause of the obstruction of the duct can only be a matter of speculation. In this case an attack of measles had occurred a few months before the cyst was first noticed, and no appreciable alteration in size had taken place since. The mother says it was not present at birth. It is therefore reasonable to suggest that the attack of measles may have had a bearing on its causation.

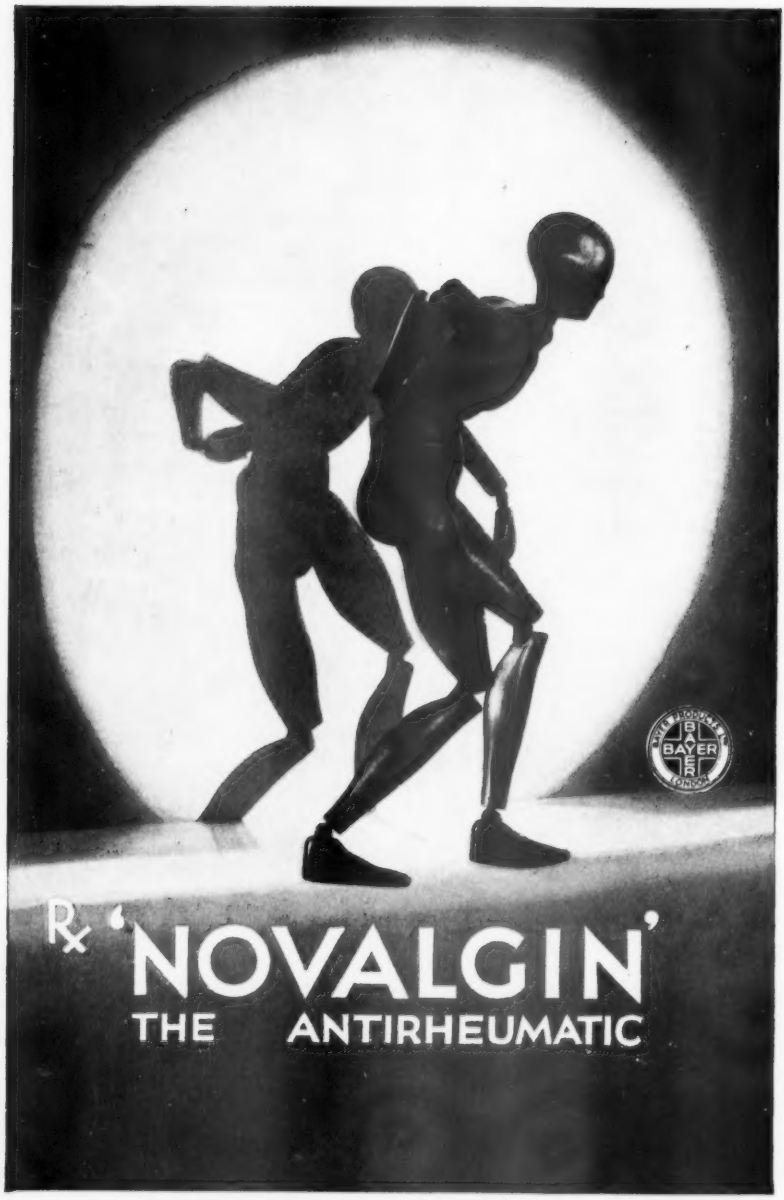
I am indebted to Mr. Gimblett for permission to publish this case, and to Mr. Wolff for his report on the pathological specimen and for the drawing of the microscopical section.

Acute Blepharitis, due to the Primula Obconica.—J. COLE MARSHALL, F.R.C.S.

The case I am describing is exceedingly interesting as a perfect example of an acute blepharitis, caused by the irritant effect of the small hairs of the primula obconica.

The patient was living in a house where there were many of these plants in pots. She first complained of an acute irritation in the eyelids. This resembled that which is sometimes caused by atropine, but no source of this kind could be found. She consulted a physician, as she had a gouty diathesis, but he did not think that this was the cause of the irritation and suggested that she should see a dermatologist, who diagnosed the condition as lupus erythematosus. The treatment prescribed had no effect on the condition; in fact, on being painted with collodion it became worse. At a second visit, numerous ointments were tried and also small doses of luminal which unfortunately caused an acute attack of scarlatiniform rash. She consulted a second skin specialist, who also had great difficulty in finding out what the cause was until some small discrete nodules were noticed on the backs of the hands. He asked if there were any primulas in the house. On being told that there were, he immediately made the diagnosis and said that these small white spots were caused by the fine hairs on the leaves of the primula obconica. On the plants being removed, the eye condition cleared up.

This type of case is described very fully in Walker's "Dermatology." This author also instances many similar conditions caused by plants, etc.



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To face Obstetrics and Gynæcology

Section of Obstetrics and Gynæcology

JOINT DISCUSSION WITH THE **Medico-Legal Society,** HELD AT A MEETING ON JULY 6, 1934

Chairman—W. BLAIR-BELL, F.C.O.G. (President of the Section)

SEX: ITS NATURE AND ABNORMALITIES CONSIDERED FROM BIOLOGICAL AND LEGAL POINTS OF VIEW

Professor F. A. E. Crew: This discussion is to open with a consideration of the nature of sex. On this matter I must perforce be silent, for the biologist no longer is concerned with the search for an understanding of the nature of sex itself; he contents himself in this stage of the development of his subject with a discussion on the analysis of those differences which permit him to regard an individual with one particular kind of characterization as a male, another with another kind as a female. The more one knows of sexual differences the less one seems to know of sex itself.

Sex would seem to be revealed by differences in the structure and in the behaviour of two dissimilar individuals, male and female respectively, of two reproductive cells, the sperm and the ovum, and in the mating between the two individuals and also between the two gametes. Thus there is a sexuality of the zygotes and a sexuality of the gametes.

Because it is the case that the mating of two dissimilar individuals can and does result in the union of two dissimilar gametes, that is in conception, nothing is easier than to conclude that the nature and meaning of sex can only be recognized by bringing it into an essential relation with reproduction. Thus sex becomes the mechanism which nature uses for the preservation of the species and the continuance of the race. And so the notion of a purpose in sex becomes revealed: to draw together two dissimilar individuals suitably matched for reproduction for their pleasure and in the service of the race.

This view is commonly held and is upheld by philosopher and cleric. Yet it is not a contribution of biology; it is an imposition upon this science. For the

biologist knows that sexuality and reproduction, though intimately related in the more commonly known forms, are in others, not only to be distinguished, but also completely dissociated. He knows that reproduction without sex is just as common as is reproduction with sex. He knows that sexual reproduction, though very different from asexual, cannot claim any great advantage. No doubt we have gained much as a result of our peculiar mode of evolution, but at the same time we have lost much.

To classify things in an order of increasing complexity is one of the commonest urges, and when this is done it is inevitably assumed that the more complex is the later in evolution. As with battle-axes in a museum, so with the phenomena of sexuality. It is a matter of considerable interest on the appropriate occasion to discuss the relation in time of the appearance of hermaphroditism and bisexuality, but though the discussion would be interesting, since at no point would it be hindered by an appeal to verifiable fact, it is doubtful whether it would be profitable. It is better that we should devote our time to a consideration of certain established facts.

(1) In an ever-increasing number of forms the existence of sex chromosomes is being demonstrated, and in such as provide a convenient material for study it is established that in a very considerable number of instances dissimilarity in the sex-chromosome constitution of male and female provides a complete explanation of how and when the sex of the individual is determined. Take *Drosophila melanogaster* as a convenient example. In this form, as in the human subject, the female is constitutionally homogametic; every egg she elaborates contains one *X*-chromosome together with one set of autosomes. The male, on the other hand, being possessed of an *XY* sex-chromosome constitution, is heterogametic, elaborating two forms of sperm, one an *X*-chromosome and one set of autosomes, the other with a *Y*-chromosome instead of the *X*. A female results from the union of an egg with an *X*-chromosome-bearing sperm, a male from the union of an egg with a *Y*-chromosome-bearing sperm. In *Drosophila* as a rule, this is the complete story, but aberrations in the chromosome-distributing mechanism can and do lead to the production of abnormal sexual types. Gynandromorphism is fairly common in this form. A lateral gynandromorph, for example, has one side of the body completely male, the other completely female. Cytological investigation shows that the cells on the female side of the body contain two *X*-chromosomes together with a double set of autosomes (that is, the typical chromosome content of the cell in the female body) whilst on the male side of the body the cells contain only one *X* instead of two. Such a gynandromorph had its origin in an egg which was a female, having two *X*-chromosomes and two sets of autosomes, but at the first division of this egg one of the daughter *X*-chromosomes became eliminated. Of the two cells which resulted one came to possess two *X*-chromosomes, the other only one. From the first, the female side of the body developed, from the second, the male side. But gynandromorphism is graded, and the significant fact is revealed that the amount or area of male characterization in a female is determined by the time during development when an *X*-chromosome is lost during cell division. The later it is lost, the less is the area that is male. It follows that the nature of the sexual characters of any part of the body is determined by the chromosome content of the cells of that part. The control of sexuality is local.

That sex determination in *Drosophila* is not a function of the sex chromosomes alone but of all the chromosomes is clearly illustrated in a study of what is known as "balanced" intersexuality. A considerable number of intersexual types, constant in their differences one from the other, have been recognized, and associated with each type there is an equally constant and characteristic abnormality in the relative number of sex chromosomes and autosomes.

Super female	...	3 *X*	chromosomes	together	with	2	sets of autosomes
Tetraploid female	...	4 *X*	,,	,,	,,	4	,, ,,
Triploid female	...	3 *X*	,,	,,	,,	3	,, ,,
Normal female	...	2 *X*	,,	,,	,,	2	,, ,,
Haploid female	...	1 *X*	,,	,,	,,	1	,, ,,
Intersex female type		2 *X*	,,	,,	,,	3	,, ,,
Intersex male type		2 *X*	,,	,,	,,	3 less one	,,
Normal male	...	1 *X*	,,	,,	,,	2 sets of	,,
Super male	...	1 *X*	,,	,,	,,	3	,, ,,

From this it would seem that the essential feature in the determination of sex in *Drosophila* is the numerical or quantitative relation between sex chromosomes and autosomes. A disturbance in their normal relationship leads to abnormal sexual types. It would seem, further, that the influence of the *X*-chromosomes is preponderantly female-determining, whereas that of the autosomes is male-determining. Intersexuality in *Drosophila* is the effect of the establishment of a certain unusual balance between the male-determining and the female-determining factors.

Next we can turn with advantage to the study of sex determination in the Gypsy moth, *Lymantria*. In this form it is the male that is homogametic, having two *X*-chromosomes, whilst the heterogametic female has one *X* and a *Y*. This is also the case in birds. Such evidence as exists points directly to the conclusions that in this form the male-determining factors are resident in the *X*-chromosome, and the female-determining factors are resident in the *Y*, and therefore are limited to the female line. Furthermore, it appears that male-determining factors can differ one from the other in respect of their "potency" as measured by the effects which they evoke during the differentiation of the sex equipment, some being "stronger" than others. The same is true of the female-determining factors. One further fact is that the female-determining factors act pre-zygotically, before the *X* and the *Y* chromosomes in the maturing egg have separated. The result of this is that, though ultimately there are two forms of egg, both the *X*-bearing and the *Y*-bearing egg are alike in respect of the female-determining reactions which have resulted from the previous functioning of the *Y*-borne factors. In the normal male, that is to say, an *XX* individual, the male-determining factors, *M*, of which there are two sets, are effectively in excess of the female-determining factors, *F*, during the whole period of development when the sex equipment becomes differentiated. In the normal female, on the other hand, the female-determining factors are effectively in excess of the male, of which there is only a single set, since there is only one *X*. But, as a result of crossing, one can get a combination of "strong" male-determining factors, for example, in association with "weak" female-determining factors, and, as a result of this there can appear *XY* individuals (that is females in respect of their sex-chromosome constitution) which are completely male in respect of their sex organization. By appropriate crosses one can get a brood consisting solely of males, but of these 50% will be completely transformed females.

What, then, is a male, and what a female?

It is to be noted that sex-transformation of this kind is made inevitable at the moment of fertilization by the constitution of the individual as determined by the quality of the male- and female-determining factors received from the two parents. Furthermore, any grade of intersexuality, either in genetic males or genetic females, can be produced by the same method of appropriate crosses. And it can be shown that the intersex is an individual, the earlier stages of whose development have been pursued under the direction of one sex-determining reaction (male or female), but whose later stages of development have been pursued under the direction of the other (female or male) determining reaction, and that the degree of intersexuality is determined by the point during development at which this switch-over occurs.

(2) In *Lymantria* the discord between the sexual characters of the individual and its sex-chromosome constitution is the result of the action of inborn genetic factors. But such discord can be produced through the over-riding of the inherent sex-determining mechanism by purely environmental agents. This is best seen in the case of *Bonellia*, in which the sex of the individual is determined by pure chance. If the undifferentiated larval form, sinking to the bottom of the waters, alights on or near the proboscis of a female, it becomes a male. If, on the other hand, it settles far away from the female, it becomes inevitably a female. Intersexual forms of different grades can be produced by allowing the larval form at the appropriate stage to settle on the proboscis of a female, or in a solution thereof, for varying periods of time, and thereafter removing it. In this case the sexual differentiation of the individual is under the control of a chemical substance present in the proboscis of the female.

From *Bonellia* it is not difficult to leap to the higher vertebrates. In these the differentiation of the part is certainly not pursued independently of that of the rest of the body, for with the development of the endocrine system there has come into being a centralized control. The case of the freemartin in cattle, a female which in spite of its sex-chromosome constitution—and presumably, therefore, the inclination to pursue its development according to the female plan—provides an example of sex transformation, probably never complete. In fact, complete sex reversal could only occur in such a form if it happened during the very earliest stages of development. In forms in which the endocrine system is largely concerned in determining the final characterization of the individual it would not be expected that gynandromorphism would exist, and intersexuality in space of the *Drosophila* kind would not be expected either. But intersexuality in time apparently can and does happen.

The popular press continually presents us with the startling news that some girl has become a boy, and that skirts have been exchanged for trousers. In the absence of any accurately diagnostic procedure, and in view of the fact that a search for the sex chromosomes is a matter for the expert cytologist with considerable experience, there are two opposing views concerning such cases. I personally support that which holds that such individuals have never been girls, and for this reason. Sexual abnormality of this kind is very common in domesticated animals. A common type is furnished by the goat which is regarded as a female whilst a kid, but suspected of abnormality when at the onset of maturity its beard begins to grow, the animal begins to smell, and on inspection the clitoris is found to be abnormally large. Within the abdomen, associated with cryptorchid testes, there are to be found very well-developed derivatives of both Wölffian and Müllerian ducts. In other cases, the external reproductive organs are obviously abnormal at the time of birth, but the internal architecture is the same. I prefer to regard these animals as males in which the stimulus, either pituitary or testicular, to the proper differentiation of the male sex equipment is delayed. In the absence of this stimulus, growth without differentiation occurs, and the degree of abnormality is determined by the degree of the delay in the expression of this stimulus. In many cases it is completely absent during that time of development when the internal reproductive organs should become differentiated, but is active at the time of puberty. In the case of domestic animals sexual abnormality of this kind possesses a very considerable interest. The individual, of course, cannot propagate, for the abdominal testis is aspermatic. But, in the case of the human subject, such abnormality can end in legal difficulty. If such abnormal individuals are indeed males, then, theoretically at least, it should be possible to provide proof of this by cytological examination of their tissues.

The rarer form of intersexuality in which both male and female gonadic tissue is to be found requires a very different explanation, and I would suggest that it is to be found in a consideration of the facts which relate to intersexuality in the Gypsy moth. It may well be that in such cases the female-determining reactions, in effective excess at the beginning of differentiation, were outpaced and overwhelmed by the male-determining reactions in the later stages. In such a case cytology could provide no help, and one must look, and certainly not in vain, to the sex physiologist and to the advances that may be expected in our knowledge of the sex hormones.

Dr. B. P. Wiesner: My contribution to this discussion will be a few remarks about the mechanisms which regulate sex-behaviour and associated activities.

Analysis of sex-behaviour could be carried out on an entirely psychological basis; one could relate sex activities to other activities in a quantitative fashion, and relate these to each other. No such analysis has ever been attempted, and I do not think it will be, so long as the historical attitude of psychoanalysis rules. But we can deal with the physiological determinations of sex-behaviour.

In the past, much confusion has resulted from identification of the motivation concerned with the offspring and with sex-drives respectively. Analysis cannot be carried out in the case of human beings because of the great variability in the external conditions. But it can be, and has been to some extent, carried out in the rat. The sex activity of the male rat is comparatively simple. The male tries to mate with any other animal of its kind, or of similar appearance, whether it be male or female. The distinction of the sexes which we call "normal" is a secondary phenomenon in evolution; it is not primary, and it is not the rule in lower animals. Mating is restricted to male with female, not because the male selects, but because other males do not permit the movements, or adopt the suitable reproductive posture. The sex act does not occur before puberty has been reached, and it fails to occur at any time if the animal has been castrated before puberty. The conclusion reached was that the testes secreted some substance presumably identical with the male sex hormone, and that this hormone produced a sex drive. But that theory is no longer tenable. We know that the testes can be removed after puberty without interfering with the sex-life of the animal, whereas complete removal of the anterior lobe of the pituitary results in the immediate disappearance of sex-drives, the animal then being indifferent to the presence of any other animal—and after twenty-four hours there is no trace of sex activity for the rest of its life. If you inject certain extracts from the anterior lobe, you can restore sex-activity, and also the general spontaneous activity which also suffers after hypophysectomy. So we have a knowledge of the substance which vitalizes the animal, and its chemical composition is open to further investigation.

When we analyse a drive we cannot be satisfied by referring to it as an entity; there are various factors which constitute the totality of the drive. If you watch animals, or human beings, you find that sex activity varies in two respects. It can vary first with respect to its intensity; it can be prolonged and vigorous, or it can be intermittent and very slight or sluggish. And it can vary in regard to the integration of the acts, and in the movements which constitute the normal sex act. The intensity and the structure vary independently of each other, or there is only very slight correlation. Moreover, in hypophysectomized animals it is possible to restore general activity without restoring sex activity.

This analysis might explain many of the phenomena which, so far, have been only imperfectly understood. The purely historical explanation of the

actual mental state cannot long be confidently retained. It is most probable that the actual physiological state of the individual to some extent determines its behaviour in any given situation. And associated with the factors which determine sex-behaviour and general activity, there are factors which determine certain specific but not easily measured activities of the animal. Rats which are wild and brutal will lose that quality entirely within a few days after complete removal of the anterior lobe. It seems that many of the factors responsible for highly dynamic motivation are associated with factors responsible for sex-behaviour. I am mentioning these things because I am hopeful that, to some extent, they may be applicable to the human subject. From the striking examples given by Henderson and others of cases of adenoma of the anterior lobe, it is evident that this condition is frequently followed by loss of libido.

In the female the conditions are more complicated, but we have a set of chemically definable factors responsible for the expression of sex. Here, however, we have a more difficult situation. In the female there is not only periodicity of sex, but also periodicity of reproductive drives in the proper sense—maternal behaviour. There are many activities concerned in the care of the young, but these are to some extent structurated and motivated by chemical factors belonging to the hypophyseal ovarian mechanism. It has been possible to evoke certain partial drives of the maternal behaviour in virgin rats by appropriate endocrine treatment; these animals accept strange young and take care of them.

But what is of particular interest is, that in certain of these cases of artificial maternity, disturbances normally observed in maternal behaviour were found. In rats and some other animals, certain situations provoked cannibalism—the mother eating the young, which is never observed in the virgin rat. The injection of extracts resulting in maternal behaviour may also produce this cannibalism, which is like certain forms of lactational or puerperal insanity.

There are many ways in which these findings might apply, but no one would want to apply them until more research has been carried out in human beings.

While stressing the importance of chemical factors in the determination of behaviour, I also wish, however, to draw attention to the fact that more recent work has shown that environmental factors play an equally great rôle, though we are at a loss to understand the relationship between the physiological and the environmental factors. It is definitely established that homosexuality in rats can be artificially induced by keeping males together for a certain time, but knowledge of these facts is as yet incomplete, and the relations between them and the physiological mechanisms are unknown.

Dr. H. Gardiner Hill: The task allotted to me is that of discussing intersexuality in man; a state between the definite sexes and one with which we only meet occasionally in medical practice, at any rate in its most complete forms. A study of this subject must include the various types of hermaphroditism, virilism in females, and sex reversal. The underlying pathology of these states must also be discussed. Unfortunately there are considerable gaps in our knowledge. As a physician, my thoughts naturally turn to the endocrine aspects of the subject; Professor Crew in his biological survey has pointed out that there are other and equally important aspects. He has discussed the mechanism of sex-differentiation and the relationship between the various influences at work. First of all, the intrinsic and hereditary genic factor, the chromosomal constitution; this is subsequently modified by both intrinsic endocrine and extrinsic environmental factors. The initial bias in sex-differentiation in man depends on the chromosomal constitution and is subsequently reinforced by the endocrine activity of the gonad proper to each sex.

It is now generally accepted that the gonads themselves provide the hormonic stimulus which leads to the growth of the accessory sexual organs and secondary sex characteristics. Experimental and clinical evidence is strongly in support of this. Prepubertal castration in the male results in under-development of the external sex organs, prostate, and seminal vesicles. Masculine distribution of hair does not occur, the beard is absent, the voice of the prepubertal boy persists. The skeleton shows characteristic changes. Ovariectomy in the female leads to corresponding results. Atrophy of the uterus occurs, the mammæ remain undeveloped and the sex cycle does not take place.

The pituitary body is also intimately connected with sex-development but it does not seem to play any part in sex-differentiation, rather exercising its effect on the gonads and bringing them to their full structural differentiation and endocrine activity. Hypophysectomy in the young animal is found to arrest the growth of the gonads and accessory sex organs whilst the administration of fresh pituitary substance counteracts these effects. In clinical work, destructive lesions of the pituitary in children, such as are found with the suprasellar cysts, are associated with a condition of infantilism and failure of development of the gonads and secondary sex characters.

The adrenal cortex provides another endocrine influence to be considered in relation to sex-development, especially to sex-reversal. Precise information as to the functions of this gland in this connexion are lacking. It is well known, however, that adrenal cortical tumours are to be found clinically associated with varying degrees of virilism in the female. It is assumed that a hormone is produced which has a masculinizing influence, though up to the present there has been no biochemical confirmation of this supposition.

Such is a brief outline of the main endocrine influences which play a part in the development of sex.

I must now approach the more clinical aspects of our subject and refer to the grades of intersexuality found in man. The first anomaly is true hermaphroditism. Here are found combined in one individual the bodily characters and generative cells of both sexes. The recorded cases have been shown to possess mixed gonads—so-called ovo-testes. The condition is rare, but Professor Blair-Bell has reported one of these cases in which a girl, aged 17, began life and passed puberty as a normal girl, menstruating regularly for eighteen months: then menstruation ceased and masculine characters developed. At operation an ovo-testis was found on one side and a normal ovary on the other. Eight months after operation she reverted almost entirely to the feminine type. Blair-Bell has pointed out that all these cases of ovo-testis have had mostly feminine secondary characteristics. To include an individual in this group he considers it necessary that the hermaphroditic gonad must be an ovo-testis, whilst the subject must show in its primary and secondary characters evidence of hermaphroditism. Several varieties of true hermaphroditism have been described, but enough has been said of this group to show their importance in this discussion.

Pseudo-hermaphroditism is the next grade which needs consideration. This abnormality is more common than the true form. Anomalies of the genital ducts and/or external genitalia are found in contrast with the gonads, i.e. the sexual glands of one sex with the secondary sex characters of the other. A number of different varieties of pseudo-hermaphroditism have been described. There is the internal form, in which the internal sex passages are of the opposite sex to the gonad; the external form in which the external passages are of opposite sex to the gonad; and the complete form in which both internal and external passages are opposite to the gonad. Every conceivable variation may be found.

We must now consider a third group of abnormal conditions, generally referred to as the adreno-genital syndrome. The association of lesions of the adrenal cortex with virilism in females is well established. The pathological lesion may be either diffuse cortical hyperplasia or neoplastic, the latter either benign and adenomatous or malignant. There are many cases recorded of both types. As Matthias has pointed out, the influence of the adrenal lesion may manifest itself in different ways, depending on the type of lesion, and also on the age of the individual at its onset. Hyperplasia, with its slow growth, does not produce such rapid changes as the malignant tumours, whilst the course of the benign adenomata is intermediate between the two. The age of onset is important too in determining the type of syndrome. The result depends on whether the organism at the time is immature or fully developed. In adrenal pseudo-hermaphroditism, the most complete form, the adrenal changes set in during intra-uterine life. Bodily development and external sex organs towards the male type are associated with internal sex organs of the female. In the form which develops in later life, the sex characters change after maturity; amenorrhœa and psychical changes of a masculine type, abnormal muscular development, with hypertrichosis of male distribution, appear. Diffuse cortical hyperplasia is usually found in adrenal pseudo hermaphrodites. In the late form—adrenal virilism—either hyperplasia or neoplasm may be present. Successful operative removal of cortical tumours has been reported in several instances: the case reported by Gordon Holmes is a good example. Here a large non-malignant and slowly growing tumour of the right adrenal was associated with changes in the sex organs, atrophy of the uterus and mammæ, hirsutism, and masculine psychical changes, all of which disappeared within a relatively short time after removal of the tumour, and left the patient again an apparently normal woman.

Such is a brief description of the main pathological varieties of intersexuality found in man. It must, however, be mentioned that these gross conditions are comparatively rare in comparison with the very large number of individuals who show signs of minor disturbances in the sexual sphere, of similar type. The occurrence, for instance, in females of slight hypertrichosis of the male type, with other abnormalities, such as poor development of the breasts and a tendency to amenorrhœa, must be a familiar experience to every physician. In these individuals the condition does not seem to be truly pathological, and there is seldom found any evidence of a gross structural endocrine lesion. It must be admitted, of course, that opportunities for full investigation of such individuals from the pathological point of view but rarely occur. One would suspect, however, that their abnormality is largely due to inherited influences, for, if one investigates their family histories, it is generally found that several other members of the family show the same tendencies. In these individuals intersexuality would seem to depend more on these hereditary tendencies than on any subsequent endocrine dyscrasia.

From this brief discussion it will be judged how difficult it is to explain the multiplicity of such phenomena in the existing state of our knowledge. How, for instance, can one account for cases of pseudo-hermaphroditism in which the gonads of one sex are found with secondary sex-characters of the other, if one accepts the evidence, which seems to be satisfactory, that the gonads themselves provide the hormonic stimulus which leads to the growth of the secondary sex-characters? One can only account for such manifestations if the view is adopted that the development of sex-characters depends on a number of factors, of which the hormonic stimulus from the gonads is only one. The pre-existing hereditary and genic factor is another, and perhaps the most important one, and then again, there is the probability that the development of some of the sex-characters is influenced by other ductless glands, such as the adrenal cortex.

The problem of the classification of these cases in civil life is very difficult. Should the character of the gonad itself be taken as the indication of the sex of the individual, or should this be judged by the nature of the sex organs and secondary sex characteristics? It seems to be usual for the psychical attributes to accord with the predominating secondary sex characters. From the purely social aspect, therefore, and for the individual's happiness, the latter alternative would seem to be more reasonable to discuss. It is difficult to lay down any hard and fast rules. At the moment it seems possible only to consider each individual case on its merits and to take into consideration, especially, any predominance of physical and psychical attributes.

Sir Bernard Spilsbury said it was his intention in opening the discussion, from the legal side, on the implications of sex, to speak only on one important aspect, which presented a medico-legal problem, namely, masochism, when it accidentally led to death in the performance of the act. Masochism was a condition in which the person subjected himself to severe physical restraint with the object of obtaining sexual gratification.

The habit was probably acquired accidentally in early sexual life. It was, in nearly all cases, practised in secret, no relative or friend suspecting the aberration, and therefore in fatal cases there might be no clue in the history which would afford a ready explanation of the conditions in which the deceased met his death, and hence there was a great liability to interpret the case as one as suicide, perhaps as one of murder. There was a case recently in London in which that mistake was made.

His own experience of these cases concerned the death of three persons in whom the interpretation was clearly that of death from masochism.

The first was that of a Cambridge undergraduate who was found dead in his chambers three years ago, under circumstances which so far suggested that the death was the result of the act of other persons that Scotland Yard was called in to investigate the case. On careful analysis, however, it was clearly established that death resulted from the acts of the individual himself, though even to the present day there were some who believed him to have been the victim of a college "rag." [Sir Bernard showed photographs to indicate the elaborate way in which the body had been tied up, yet with the precaution of leaving the last knots secured by a bow or slip-knot, to allow of ready release.] The body was lying between three cushions, in one of which the face was partially buried. In addition to a series of handkerchiefs tied round the face and head, a length of electric flex ran up the back, and this was tied to a bandage round the ankles. When the handkerchiefs were removed, another was found projecting from the mouth, and it included a piece of sponge.

Several features indicated that the individual must have tied himself up, among them the fact that bows instead of knots were used. A handkerchief encircled the wrists, and was twisted four of five times between them. What happened probably was that, being thus tied up and almost helpless, he had missed his footing and had fallen to the ground, striking his head and partly burying it in the cushion, and he was suffocated before he could release his hands to change his posture.

The second case was that of a man aged 34, a chemist's assistant who was found dead under circumstances which might have pointed to suicide but for one fact. He was placed in charge of the shop while his master was on holiday, and at night he was the only person on the premises. In the morning a boy found him hanging from the banisters. He had slipped a suspending cord over the banisters of the landing immediately above, and had stood on a stair from which he had let himself go

and he was found suspended. He would only have had to put his foot back in order to save himself. Beneath the cord around the neck was a towel which had been folded eight times with the object of reducing the pressure of the cord. He was stark naked, and was wearing a condom, clearly showing that his was a sexual offence and that the death was accidental. Around his waist was a deep indentation, as if something had been drawn tightly round it, and on his bed was found a cord with a loop and slipknot.

The third case was that of a boy aged 18, a law student, who was found dead lying by the side of his bed. There was no unusual history, he was a quiet, studious youth. His death was due to strangulation. He had lain at full length upon the bed, close to one side, and had strapped himself to the iron bar beneath the mattress, using five straps and cords altogether. He had then rolled himself over the edge of the bed, and was suspended by the five straps, one of which pressed on the neck sufficiently to produce death.

In these three cases of masochism the interpretation might well have been that the deaths were suicides, or, in the first case, murder. All were asphyxial deaths, as are most of those following masochism. Whether attempted asphyxia might be the stimulus to the sexual act in some, or whether asphyxia was the chief accidental cause of death in these cases, it was difficult to say, but many cases which coroners' courts had found to be cases of suicide, apparently motiveless, in which unusual methods had been employed, were probably cases of accident occurring during the performance of acts of masochism.

Professor W. Blair-Bell (Chairman) said it was generally recognized that the primary determination of sex was related to the sex-chromosomes in the gametes and the zygote, which, of course, carried hereditary factors. The *Y* chromosome appeared to be a variable one. Other influences, endogenous (hormonal) and environmental, might also be concerned. To all these Professor Crew had referred. He had, however, dealt with insects—*Drosophila* and *Lymantria*—and with the extraordinary marine worm *Bonellia*, in all of which sex was diœcious (distinct in different individuals).

He (the speaker) wondered what was the explanation of true natural hermaphroditism (monœcious state) with the power of self- or cross-fertilization, which was to be seen in certain of the lower invertebrates, such as the earth-worm. Here surely all sex-chromosomes must be similarly constituted.

Professor Crew had also described gynandromorphism in *Drosophila* and in birds, a condition in which one half of the creature showed masculine secondary characteristics, and the other half feminine. Bond, of Leicester, had described this rare state in a pheasant. It was to be remembered that in birds the left ovary only underwent functional activity. He (the Chairman) had seen aged hen game-birds assume the plumage of the cock, but he had not encountered gynandromorphy. Nevertheless, he felt that the chromosome theories in regard to this state were not altogether satisfactory. One could understand a complete or partial transverse (segmental) transformation under hormonal influences—indeed he had himself seen a duck with a tumour of the suprarenal cortex with the head-plumage of a drake—but it was the *longitudinal* division in regard to sex characters that was difficult to understand.

Professor Crew had become almost Einsteinian in his references to space and time, but probably "distribution" and "period" were better terms for ordinary use. This was especially so in respect of intersexuality in man, in whom mathematics were more concerned with the extent or degree of masculinity and femininity.

Dr. Gardiner-Hill had discussed human intersexuality, and had laid stress on the effects of cortical lesions of the suprarenals and tumours of the pituitary in the production of masculinity.

It was important, in reconciling the facts of sex-determination and sex-alterations, to regard as a fallacy the idea that the gonad was the primary characteristic of sex, or the arbiter of the sex-fate of the individual. Undoubtedly the background of sex was reproductive necessity, and the sex-chromosomes and their genes were the first determining factors. Environmental conditions probably produced little effect in the human subject yet it was clear that for the first eight to ten weeks of embryonic life it was not possible to be sure whether the embryo would eventually be a male or a female, and, whatever the final result, there remained anatomical structures of the opposite sex. Now it was also evident that the "genital system of ductless glands" (as he, the speaker, had called certain endocrine organs) had male- or female-producing tendencies which might be regarded as primary sex-characteristics; and, as a result, alterations might occur when these organs were over- or under-active. Thus it came about that in man and in other dicœcious mammals aberrations in sex-constitution might occur during embryonic life, when partial hermaphroditism was produced as had been shown by Neugebauer, Glynn and others, or as a post-natal phenomenon, when virilism—associated with precocity in children—or feminism was seen.

Prenatal disturbances were chiefly related to the suprarenal cortex, and postnatal to this organ and to the pars anterior of the pituitary.

Broster and Vines had found fuchsinophil cells in the suprarenal cortex which were regarded as masculinity-producing elements, and Noble Chamberlain had observed sex-differences in cholesterol content of the same organ.[1]

With the pars anterior of the pituitary it seemed to be a question of over- or under-secretion. Adenomata alone, or associated with acromegaly, caused virilism, and he (the speaker) had seen enormous hypertrophy of the clitoris in this condition. Pressure atrophy of the pars anterior caused feminism in men.

Partial hermaphroditism, however, was the condition which most often led to legal difficulties, although the effects of virilism and sexual precocity could not be left out of consideration.

With regard to partial hermaphroditism, the three types, external, internal, and complete tubular partial hermaphroditism were well known. Glandular hermaphroditism, to which Dr. Gardiner-Hill had referred, and of which he (the speaker) had described a case, was extremely rare.

External tubular partial hermaphroditism was by far the most common form [Professor Blair-Bell showed slides of two of his cases—a "male" and a "female"—and discussed the characteristics present. The first might have been indicted, if the legal definition of sex depended on the gonad, on the charge of homosexuality. "His" husband could have secured annullity of marriage; and "he" could have inherited a peerage. The speaker challenged the lawyers present to discuss these legal implications. In his own view the subject illustrated was an extremely attractive woman with testes which, to avoid complications, should have been removed; but perhaps the lawyers would then have regarded "her" as a eunuch!]

The points to be emphasized in this type of case were:—

(1) The secondary characteristics were opposite in character to the nature of the gonad. In the male, interstitial cells in the abdominal testes were very profuse,

[1] In the buck rabbit Chamberlain obtained an average percentage in the suprarenals of 7·4 of cholesterol, and a cholesterol ratio (amount in mgm. of cholesterol in both suprarenals divided by the body-weight in kg.) of 16. In non-pregnant does the average percentage of cholesterol was 12·3, with a cholesterol ratio of 23. In pregnant does this remarkable difference, amounting to 66%, disappeared. The average percentage of cholesterol in the spleen, liver, kidneys, and brain, did not differ much in the two sexes.

but had no influence in checking the secondary characteristics of the female, in spite of the views of Keith and others.

(2) Female secondary characteristics in association with testes were always better developed than were male secondary characteristics in association with ovaries.

(3) In these circumstances ovaries were always more fully developed than testes. This might have some relation to the fact that the temperature within the abdomen was supposed to be different from that within the scrotum.

Sex-definition depended, then, not only on the character of the gonad, but, in the presence of abnormalities, on the preponderance of secondary characteristics which included the psychology of the person concerned. Even normal men and women varied greatly in the amounts of maleness and femaleness in their constitutions.

Dr. Leonard Browne: Sir Bernard Spilsbury's account of three cases of masochism which resulted in accidental death is of great interest, particularly to anyone who is concerned with the treatment of sex perversions and aberrations by psychological methods. Masochism expresses itself in a great many different ways. Fortunately few of these manifestations endanger the life of the subject.

The opposite condition, sadism, in which the individual desires to inflict pain on someone else, is also of great medico-legal importance as the expression of it is liable to bring the patient into the hands of the police. A few weeks ago a case of this kind was reported when a young man was charged with having thrashed a girl, of whom he was fond, in a garage. He was sentenced to eighteen months imprisonment though the sentence was eventually quashed by the Court of Criminal Appeal.

With regard to the three cases which Sir Bernard has described it would be useful if he could state whether any evidence was found of seminal ejaculation having taken place. Such evidence would be valuable in corroborating the opinion that all these were cases of masochism.

Mr. L. R. Broster said that he could only add to the discussion in so far as the adrenal gland had a bearing on sex. It was only to be expected that the behaviour of the sex chromosomes, especially that of the "Y" male chromosome, as pointed out by Professor Crew, should lead to a wide variation in our clinical groupings, as demonstrated by Dr. Gardiner-Hill. Changes in sex characters were definitely related to lesions of the adrenal cortex, and as a result of 16 cases of successful unilateral adrenalectomy for virilism and pseudo-hermaphroditism at Charing Cross Hospital, Dr. Vines had been able to show that in each the protoplasm of the cortical cells, when stained with fuchsin, assumed a vivid red colour which was absent from a series of controls and from all post-mortem adrenals. Furthermore, this staining reaction was present in the fœtus of both sexes, more marked in the male, roughly between the tenth and twentieth week, and then disappeared entirely. A fuchsinophil reaction in the adrenal cortex was therefore associated with a masculinizing influence, and virilism might be regarded as the postnatal development of a phase which is present in the fœtus.

A similar staining reaction was obtained in the interstitial cells of the testes and the anterior lobe of the pituitary. Two fœtuses, which showed an abnormally prolonged fuchsinophil reaction in the adrenal, were associated with enlargement of the pituitary. This research therefore tended to add histological proof to the clinical observations that these three organs were intimately concerned with the question of sex.

Pseudo-hermaphrodites were invariably brought up as girls, and in two such adults bilateral orchidectomy had been performed. The legal criterion of sex was that of the gonad, and both these persons determined to continue as women.

Psychical changes were not uncommon and should be considered in medico-legal adjudication.

Dr. Margaret Lowenfeld: In reference to the exceedingly interesting account and demonstration by Sir Bernard Spilsbury, perhaps it is of interest that in the study of neurotic children, tying themselves up, or wishing to tie others up, is of relatively frequent occurrence. This can go so far that in a case recently referred to us of a boy, aged 5, the tying-up had been so severe that it took his parents over half an hour to untie him.

I was particularly interested in the emphasis laid by Sir Bernard on asphyxiation, because it occurs to me that in a number of cases of children who wish to be tied up, and also in other neurotic children, the desire to be throttled or to throttle other people is also fairly frequent.

I would like to suggest therefore the possibility in cases such as those described by Sir Bernard Spilsbury, that these are instances of a masochistic trend in a neurotic individual which has been in existence throughout the pre-puberty period of childhood, and which is so greatly strengthened by the development of post-puberty emotion that it becomes a danger to the individual.

Professor Crew (in reply) said that he agreed with the President that the facts and theories relating to intersexuality and to gynandromorphism in the insect could not be applied unmodified to the case of sexual abnormality in man, but he thought it was not improbable that a study of these conditions in the bird, in which hormones were potent agencies in differentiation, had much to offer to the present discussion. Differences in size of the bones of the two sides of the body, and therefore of the two sides of the body itself, could result from chromosome elimination, followed by a difference in the growth rates of the two sides. Oöphorectomy in the hen was followed by the growth of a testis-like organ on the right side; testis-like, not only in appearance, but also in the matter of hormone production. It had been shown that in the case in which the two sides of the body exhibited different growth rates, and in which both male and female sex hormones were present, it was possible to get an individual with male characterization in respect of plumage colour and structure on one side, and with female characterization on the other. Further, by injection of sex hormones into the incubating egg it was possible to obtain truly intersexual forms.

It was perfectly warrantable to assume that in man chromosome loss during cell division was a common occurrence, and further, that such chromosome elimination was responsible for certain abnormalities in the transmission of hereditary characters.

He knew that the Chairman was unable to accept the suggestion that the cases of intersexuality in domesticated animals to which he (the speaker) had referred offered any satisfactory explanation of the curious cases of the human subject which Professor Blair-Bell himself had reported. However, he held to the view that the explanation offered could be applied to a considerable number of human cases though certainly not all. But as knowledge of the sex hormones and of the cytological background of sex was advancing so rapidly, doubtless in the future these cases would be subjected to a much more detailed examination, and from this much information must be derived.

Referring to Dr. Broster's remarks, he hazarded the suggestion that in this form of virilism the factor to be sought seemed to be one which took part in the chemical transformation of the female sex-hormone into the male.

Sir Bernard Spilsbury (in reply) said he recalled the case of a person who had passed as a young man and who died in his bath of congenital heart disease. Though he had the secondary sex characters of a man, and the build of a man, the external sex organs were much like those of a woman; he had a uterus and a tube on one side and a testis on the other, the latter poorly developed, like that of a cryptorchid.

In answer to a question by the Chairman, he (the speaker) could not recollect any fatality in connection with masochism in the female.

As to the ejaculation of seminal fluid in cases of masochism, there was no evidence of this in his cases, but probably the deaths occurred before the stimulus could produce ejaculation. In the case of the chemist's assistant who wore a condom, the doctor who was called did not examine the condom for spermatozoa, but threw it away.

He was interested to hear that the practice could occur in the pre-pubertal period, but when it occurred after puberty it took on a sex significance. There was evidence that in at least one of his (Sir Bernard's) cases tying-up had been practised as an amusement at an earlier age.

Section of Otology

President—Mr. W. J. Harrison.

[*March* 2, 1934]

DISCUSSION ON THE DIAGNOSIS AND TREATMENT OF ABSCESS OF THE BRAIN

Opening Papers: **(I) Hugh Cairns, F.R.C.S., and Charles Donald, F.R.C.S.**
(II) Sydney Scott, F.R.C.S.

(I) Mr. Hugh Cairns and Mr. Charles Donald: In opening this discussion on abscess of the brain, we will first describe methods of operation and then analyse our own material, especially the failures.

Thick-walled Chronic Abscess

Abscesses of long duration usually have thick walls, 0·5 cm. or more in width. This group includes abscesses that for long periods have given rise to no symptoms, and abscesses which after one or more operations have continued to discharge through a sinus. Our experience shows that for these cases complete removal of the abscess and its wall is the only satisfactory treatment. Thick-walled chronic abscesses tend to be loculated or even multiple, and treatment by drainage alone will rarely result in collapse of the abscess sac. Moreover, the wall of the abscess will never be absorbed and will persist in the brain as a foreign body, which produces gliosis and is likely to result in further abscess formation at a later date. The first two cases provide examples of abscesses of this type, the one treated unsuccessfully by drainage, the other successfully by complete excision.

Case 1.—*Chronic abscess of right temporal lobe following gunshot wound thirteen years before. Drainage of abscess and removal of foreign body. Progressive fungus cerebri. B.* pyocyaneus *meningitis. Death. Latent chronic abscess in right occipital lobe.*

History.—G. S., aged 34, referred by Mr. Charles Goulden, had been wounded in the right parietal region by a bursting shell in 1915. A piece of shell was taken out of his brain twenty-four hours later, and he returned to light duty within three months. In 1919 he began to have paroxysmal attacks of headache, and in 1921, generalized convulsions. From 1924 onwards visual hallucinations occurred. He came to the London Hospital in April 1928 because his vision had been failing during the previous nine weeks.

Examination.—He had severe bilateral papilloedema, and visual acuity was $\frac{6}{9}$ in the right eye and $\frac{6}{9}-$ in the left eye. There was left homonymous hemianopia. Smell was lost at the right nostril. The abdominal reflexes were diminished on the left side, and the left plantar reflex was extensor. X-rays showed a foreign body in the right temporal lobe and an oval hole in the right parietal bone (fig. 1).

Operations.—On April 4, 1928 an abscess of the right temporal region was drained through a small incision. It lay at a depth of 2 cm. below the surface of the brain, and its capsule was so thick that a scalpel was needed to open it. The abscess was imperfectly exposed owing to great tension of the surrounding brain. Films of the pus showed staphylococci, but no organisms could be cultivated.

After this operation a fungus cerebri formed at the site of exploration (fig 2). The visual acuity and hemianopia became worse, and accordingly a second operation was performed on May 15, 1928, at which the capsule of the abscess was partially dissected out; the foreign body was removed and a hitherto undiscovered loculus of the abscess passing forwards was opened and drained. The condition was as shown in fig. 1. During the course of this operation a diverticulum of the right lateral ventricle into the fungus was opened.

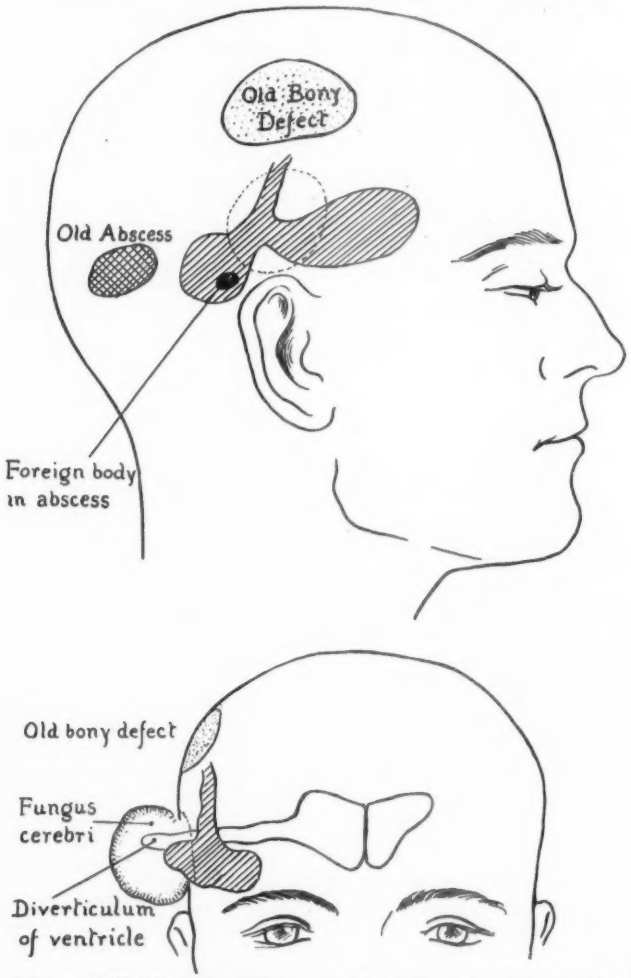


FIG. 1. *Case* 1.—Multilocular right temporo-frontal brain abscess following gun-shot wound. Latent abscess in right occipital lobe.

Subsequent course.—For the first two weeks after the second operation progress was satisfactory: the leakage of cerebrospinal fluid lessened and the fungus became smaller and began to heal. On June 4 signs of meningitis developed (*B. pyocyaneus* on culture of the cerebrospinal fluid) and the patient died on July 5. During the last two days of his life he had hæmatemesis, presumably from an ulcer in the œsophagus or fundus of the stomach.

Necropsy showed a moderate degree of basal meningitis and purulent ventriculitis. The abscess cavity in the right temporal lobe was empty and communicated with an outward prolongation of the right lateral ventricle. In the right occipital lobe (fig. 1) there was a solid

FIG. 2. *Case* 1.—Fungus cerebri following drainage of right temporal abscess. Two drainage tubes are seen at the postero-inferior edge of the fungus.

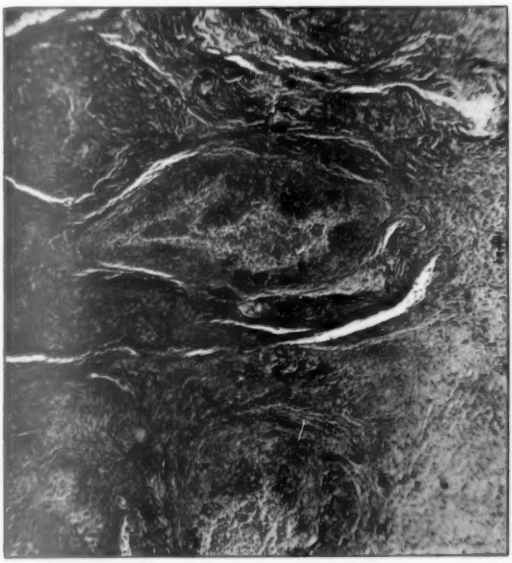


FIG. 3. *Case* 1.—Abscess of right occipital lobe. Areas of pus-cells are surrounded by dense layers of collagen. × 20.

mass of glistening white and yellowish-white tissue measuring 4·0 by 2·2 cm. which in places was almost cartilaginous in consistence, and which was found microscopically to consist of hyaline fibrous tissue interspersed with numerous old abscesses (fig. 3).

The only satisfactory way of dealing with this case would have been to dissect out the whole abscess, and to do this a wide osteoplastic exploration would have been necessary. Even if this had been done, it is likely that the latent abscess in the right occipital lobe would have been overlooked and would have become active later. From this case we learnt that it is futile to treat a chronic abscess with very thick walls by drainage, and accordingly, in the next case of this type exploration was made through an osteoplastic flap.

Case 2.—Chronic abscess of right parietal lobe following gunshot wound nineteen years before. Complete removal. Recovery.

History.—A. G., aged 47, referred by Dr. Henry Cohen, was first seen on February 5, 1934. In 1915 he had been wounded by a bullet which cut a groove in the right parietal bone but apparently did not perforate the brain. He was unconscious for a few moments only and was able to walk back to the dressing station. He was discharged from hospital six weeks later apparently well, though from that time onwards he considered that he was a little sluggish mentally. He returned to duty, but in 1921 he suffered for about a year from numbness of the left arm and leg and a strong tendency to deviate to the left when walking. The condition was diagnosed as peripheral neuritis and he was put on half pay. After several months the symptoms cleared up completely, except that from that time onwards he had numbness in the sole of the left foot whenever he was tired. In the following year he began to have occasional generalized headaches, but these were only slight until 1930, when they became severe after stooping in the garden. In 1931 he had an attack of tingling in the left upper limb spreading to the left lower limb, which was followed by clonic movements of the left upper limb. The attack lasted five minutes and there was no loss of consciousness or any residual symptom. He continued living a fairly active life until November 1933, three months before admission, when he began to notice difficulty in seeing to the left while driving a car. Shortly after this the headaches changed in type, becoming frontal rather than generalized and worse on the right side, present on waking in the mornings, and much more violent and frequent. He began to lose control of his left hand: "It did things on its own" if he didn't watch it, as for example putting his table-fork into his pocket. After he had put his matchbox away in his pocket he would still "feel" it in his hand for a long time. At other times he would find it difficult to put down an object held in his left hand: he would still be holding a cigarette case in his left hand when he wanted to use the hand for something else. At times, for no reason that he could discover, he would have his left fingers and thumb outstretched while walking about.

This loss of control in the left upper limb was progressive and was accompanied by clumsiness of the left foot. He could walk quite well but the toes of the left foot caught in every rug and it was not easy for him to put his left leg into his trousers. When walking he had difficulty in readjusting his direction: he would walk from a room into a corridor and instead of turning right or left would go straight ahead into the opposite wall, "as if his brain wasn't working." There was no difficulty in finding objects that were in his field of vision, nor any other evidence of visual disorientation. He described it as being unable to concentrate on the direction in which he should walk.

Nine weeks before he was first seen he had a second Jacksonian attack exactly similar to the one three years before. Shortly after this there was temporary improvement in the functions of the left arm and leg, but this lasted only three days and soon his leg began to give way at times, and once he fell. He became mentally slower.

Examination.—He was slow in answering questions, but otherwise his intelligence appeared normal. There was a groove in the posterior part of the right parietal bone with a depressed scar adherent to it. X-rays showed an irregular fragment of bone in the depths of this bony defect. The optic discs were swollen (right, 4 D; left, 4·5 D). Visual acuity, $\frac{6}{12}$ in each eye. Incomplete left homonymous hemianopia, more in the lower than in the upper quadrants. Slight ptosis of right upper eyelid. Slight weakness of the lower part of the face on the left side.

The left upper limb was a little smaller than the right and was slightly weak at all joints. At times, when he was concentrating, the left upper limb would assume some unusual posture: for example, during fixation while his visual fields were being tested, his left forearm was flexed and his left hand was held rigidly outstretched in front of him against gravity for the duration of one series of tests. Tone was slightly increased in the left arm and leg. The

upper limb-jerks and the knee-jerks were all diminished, more so on the right side than on the left. The ankle-jerks were absent.

There was severe sensory loss on the left side. There was anæsthesia of the left leg below the knee, relative analgesia of the left leg and, to a less extent, of the left forearm and hand, severe postural loss in the left thumb and big toe, gross defect of two-point discrimination in the left arm and leg, considerable impairment of tactile localization and relative astereognosis of the left hand. The leucocyte count was 7,520 per c.mm.

Operation.—February 10, 1934. Under avertin and local anæsthesia a right osteoplastic flap was reflected. It was felt that the lesion might be an abscess or a tumour, but that in either case a wide exploration should be made. A chronic abscess was found occupying the inner half of the right parietal lobe. Its anterior extremity was just behind the site of the old gunshot wound; its posterior extremity extended to within 4 cm. of the tip of the occipital lobe. On the convexity the dura was densely adherent to its central part. Medially it was separated from the falx by a thin shell of white matter. The abscess and its capsule

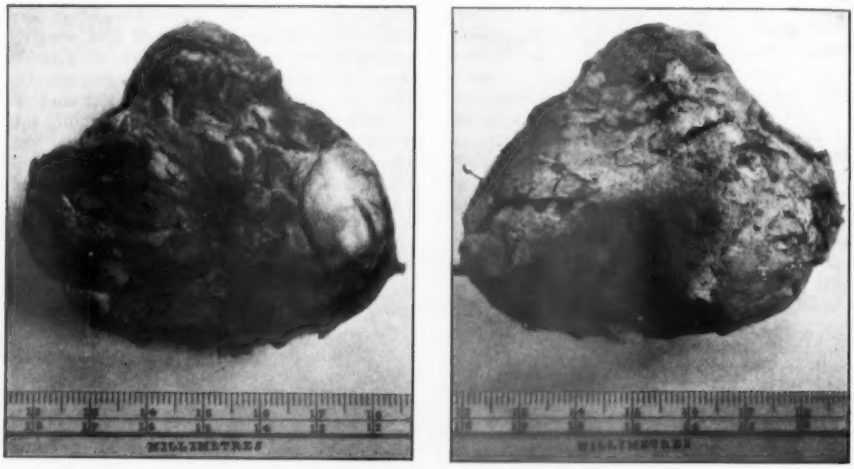
FIG. 4. *Case* 2.—Right parietal abscess, following old gun-shot wound, dissected out intact with its capsule.

were dissected out intact and the resulting cavity measured 7 by 4 by 5 cm. (fig. 4). A gutta-percha drain was put into it and the flap replaced and sutured in the usual way.

Pathology.—The abscess and its wall weighed 85 grm. (fig. 5). After removal it was aspirated and the pus, examined by Dr. Panton, contained degenerated pus cells, numerous Gram-positive cocci, and fatty crystals. Culture yielded a pure growth of *Staphylococcus aureus*. The organism was hæmolytic and in broth grew in "rough" form.

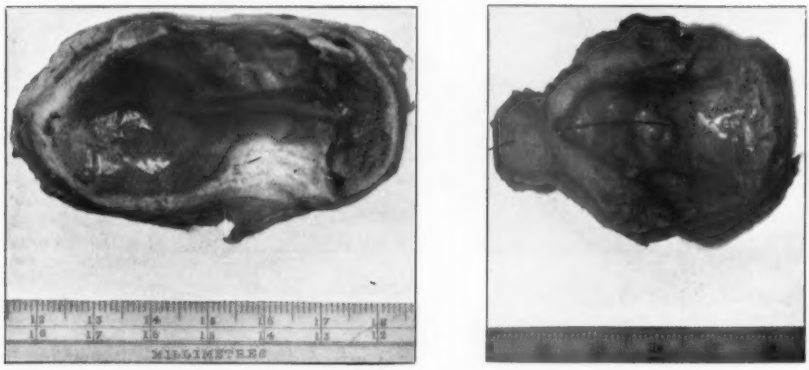
Section of the abscess showed that it consisted of a single large cavity and a smaller loculus occupied by inspissated pus which communicated with the main cavity by a foramen, 0·3 cm. diameter (fig. 6). Its wall measured up to 0·6 cm., thick and that part of it which had been beneath the old gunshot wound in the parietal bone was found to contain a fragment of lamellar bone, measuring 0·5 by 0·3 cm. Contrary to what was thought at the time when the patient was wounded, a small fragment of bone had evidently been driven through the dura and formed the starting point of the abscess.

Subsequent course.—Convalescence was uneventful, except for one focal attack of a sensory character in the left arm and leg, on the second day after operation. Papillœdema subsided with preservation of good vision and the visual fields expanded to their normal limits. There



(*a*) (*b*)

FIG. 5. *Case* 2.—Abscess after removal: (*a*) superficial surface showing adherent dura; (*b*) deep surface, showing white matter adhering to the wall of the abscess.



(*a*) (*b*)

FIG. 6. *Case* 2.—Abscess after removal: (*a*) interior of abscess cavity; (*b*) horsehair leading from small loculus into main abscess cavity.

was complete recovery of all forms of sensibility in the left upper and lower limbs, and all disability of motion disappeared. The ankle-jerks were still absent. At the last report six months after operation the patient was living a normal life.

This case has not been observed long enough to allow one to judge of the ultimate result but the immediate result provides a great contrast to what happened in Case 1. There is little doubt that drainage alone would have been unsuccessful in Case 2 because the small outlying loculus could never have been drained satisfactorily, and

moreover, the capsule of the abscess was so thick that it would never have been absorbed. The appearance of the latent occipital abscess in Case 1 (fig. 3) probably represents the best that can be hoped for when an abscess of this type is drained or subsides spontaneously.

It is probable that recurrent or very chronic abscesses secondary to infection of the temporal bone should be treated in the same way, but in such cases the capsule is not usually so thick and there is almost always a discharging sinus, a fungus, or a cerebral hernia which will make it difficult—if not impossible—to reflect an osteoplastic flap because of the risk of spreading meningitis from organisms around the sinus. We have had no personal experience of such cases but one of us saw Dr. Harvey Cushing deal very successfully with such a problem in a case of frontal abscess. The patient was a young girl with a left frontal abscess following frontal sinusitis. This abscess had been opened and drained some ten months before, but the resulting sinus had never healed completely and a large cerebral hernia formed at the site of operation, from which pus discharged spontaneously from time to time, with temporary improvement of symptoms. At operation Dr. Cushing enlarged the bony opening of the sinus, dissected out a thick-walled abscess cavity the size of a hen's egg from the left frontal lobe, and then found behind this two other abscess cavities which extended back an amazing distance into the left hemisphere. Their walls were not so thick as those of the first abscess and accordingly, after they were partially drawn out of the wound, they were sutured to the skin. The huge cavity was drained with large gauze wicks each surrounded by gutta-percha. Eleven weeks later the whole wound was healed with complete subsidence of the hernia, and the patient had regained normal health.

Acute and Early Chronic Abscess

A chronic abscess has a distinct wall, composed from within outwards of pyogenic membrane, a zone of chronic inflammatory cells, a zone of fibrous tissue and, outside that, a zone of gliosis. This wall offers a variable degree of resistance to the passage of a brain needle. An acute abscess has no such wall; it is lined by shaggy soft material and a brain needle entering the abscess cavity meets no resistance. Acute abscesses are rarely encountered at operation, except those that are secondary to bronchiectasis, and it is doubtful whether abscesses should be operated on in the acute stage. It is impossible to drain an area of acute purulent encephalitis and it is probably unwise to disturb an abscess before it is localized. Diagnosis of abscess thus does not always indicate immediate operation.

Finding the abscess.—The best chance of getting complete and satisfactory drainage of an abscess is to drain it at the point where it is nearest the surface of the brain. If every abscess spread from neighbouring foci of infection along a visible track, this would be a relatively simple business, but, as W. Evans [1] has shown, even abscesses arising from mastoid and frontal sinus infection are very often entirely subcortical and without tracks visible to the naked eye. Evans found, when investigating the post-mortem records at the London Hospital, that in 43 of 109 cases of brain abscess secondary to otitis media and mastoiditis, there was to the naked eye no evidence of a track or of direct spread.[1]

The problem of finding the abscess is primarily a clinical one, of diagnosing the general situation of the abscess, then of going through the history and signs again to see if there are any points indicating greater precision in diagnosis. For example, in temporal abscess after mastoid infection, the type of field defect may indicate that

[1] In histological studies of what appeared to the naked eye to be a subcortical abscess of the left frontal lobe Dr. Dorothy Russell has found a minute track leading from the extradural space through the dura into the abscess cavity. This observation is of importance in indicating that subcortical abscesses without a visible track from the surface are not necessarily the result of infection by the blood-stream.

the abscess is higher than usual, or the type of aphasia may indicate that a left temporal abscess is further back than usual.

It is best to be prepared to explore over a wide field. The scalp should be shaved over a wide area, and in males, if the case is not urgent, the whole scalp may be shaved, not only to give freedom in exploration, but also to facilitate dressings after drainage of the abscess has been established.

The method of exploration is as follows: The scalp is infiltrated with 1% novocain, and a hole about 1·5 cm. in diameter is made in the skull with perforator and burr. The dura is opened and the brain is explored with a graduated brain needle. The needle passes unusually easily through œdematous brain matter around an abscess, and the first definite indication that it has reached the abscess is usually a distinct resistance, as its point impinges against the capsule. It may be necessary to use for a moment firm pressure in order to perforate this capsule. When the abscess cavity has been entered its extent may be ascertained by passing the needle very gently onwards until the resistance of the opposite wall is felt. At the same time it is necessary to decide if possible whether the abscess has been tapped at the point where it is nearest the surface. If the brain needle has been passed very obliquely, it is better to make another opening in the skull so that another needle passed at right angles to the surface will enter the abscess. The first escape of pus may sometimes be preceded by bubbles of gas, and this indicates that the uppermost part of the abscess has been entered. In one of our cases the needle entered the abscess, but yet no pus escaped even when aspiration was performed; when the needle was withdrawn its eye was found to be blocked by fibrino-purulent material. Sinus forceps and needles with sharp points should be avoided.

There are various ways of draining an abscess after it has been found. Dandy [2] has recommended repeated tapping of the abscess without aspiration, without any form of drainage between tappings.[1] We have not found this satisfactory. There is a brisk interchange of fluid between the œdematous brain and the abscess, and the abscess cavity may sometimes fill remarkably quickly. Some form of continuous drainage is necessary, and this can be done blindly by the closed method, or under direct vision by the open method.

Drainage by the Closed Method

After the abscess has been encountered at a favourable site the following is our usual procedure: The depth of the abscess from the dura is carefully noted on the graduated brain needle, and the needle is withdrawn before much pus has escaped. The bony opening is enlarged to 2 or 2·5 cm. diameter. The dura is then opened more widely and the distal end of a new Jacques rubber catheter (size 10), or an old-fashioned webbed intratracheal catheter is pushed into the brain in the same direction as the needle to the required depth. But first the distance of the brain abscess from the surface is measured off along the catheter from its eye and a piece of black silk is tied around the catheter at a point 1 cm. beyond this. Otherwise it is impossible to judge accurately how much of the catheter should be passed into the brain.

If the catheter enters the abscess, as is shown by a free flow of pus from its lumen, the catheter is left in situ and is cut off about 2 cm. above the surface of the skin and a dressing is then built up around it and the whole head encased in starch to ensure that the catheter does not move (fig. 7). Coleman [3, 4], who has been chiefly responsible for introducing this method of drainage, has advised that the catheter should be stitched to the skin.

[1] More recently Dandy [9] has advised that this method of treatment should be supplemented by subtemporal decompression on the side of the lesion, in order to give an added margin of safety against rise of intracranial pressure, and at the same time to provide direct indication, from the tension of the cerebral hernia, when further tapping is necessary.

FIG. 7. *Case* 5.—Left frontal abscess after localized acute osteomyelitis of frontal bone. Stages of dressing: (*a*) A dressing is built up around the tube which has been passed into the abscess cavity; (*b*) an assistant holds this dressing in place with a long piece of gauze while the casing of gauze and starch bandages (*c*) is applied; (*d*) the patient on discharge from hospital. The osteomyelitis was drained through the mid-line incision, the left frontal abscess through the smaller incision.

Sometimes the catheter will not perforate the abscess wall. If the condition of the patient is not extremely urgent, it is best then to leave the tube lying against the wall of the abscess for a few days. Then at the next dressing manipulation will usually result in the tube penetrating the now softened abscess wall and the pus will be promptly discharged.

Case 3: *Right frontal abscess.*—E. N., a woman aged 25, referred by Dr. O. Leyton, was operated on for a right frontal abscess following frontal sinusitis on April 16, 1930. Under novocain anæsthesia a burr hole was made above the right frontal sinus. Pus was encountered at a depth of 3 cm. and 10 c.c. were withdrawn. A rubber catheter was then passed into the brain to the requisite depth and 1 cm. beyond, but no pus was obtained. It was left alongside the abscess wall and a dressing was applied.

During the following days she vomited several times and her temperature rose to 101° F. and the pulse-rate to 110, but she was free from headache. Five days after the operation (April 21) she complained of headache and the dressing was then done for the first time. When the indwelling catheter was twisted pus began to flow through it and 20 c.c. were

collected. At the second dressing on April 25 a considerable amount of pus was found in the dressings, and there was a little more at the next dressing on April 30. On May 3 the tube was removed and replaced by a strip of folded gutta-percha and this was removed on May 7. The patient made a complete recovery.

Skiagrams, taken while the catheter was still in the brain (fig. 8), show that it had been passed in a somewhat medial direction and this probably explains why it did not enter the abscess cavity at the time of operation.

This patient had fairly severe rise of intracranial pressure before operation, but she was not drowsy or lethargic and consequently there was no need for immediate evacuation of the abscess. If the patient's condition is so urgent that immediate drainage of the abscess is necessary, and the rubber catheter will not go in, it is best to use a firm intratracheal catheter and even to put a stilette in its interior while it is being passed.

If the abscess is very deep-seated (i.e. 4 to 5 cm. or more) and the catheter cannot be pushed into it, it is usually best to leave the brain needle in situ, or, as recommended by Coleman, to mount a cannula on the brain needle and when the abscess has been entered to withdraw the needle leaving the cannula in place. A brain needle with an adjustable flange has been designed by one of us [C. D.] for cases of this type.

Sometimes the pus encountered may be too thick to pass through a brain needle. In such cases drainage by the closed method will be ineffective and the abscess must be emptied by suction under direct vision.

Drainage by Open Methods

Drainage by open methods may be done through a limited opening in the skull over the abscess, or by wide osteoplastic exploration.

(*a*) *Through a limited opening.*—For drainage by direct vision it is usually necessary to have an opening in the skull and dura 3 to 4 cm. in diameter. After the pus is found with a needle, the cortex is incised and some special form of retractor such as a bivalve speculum is passed down into the abscess. Adherents of this method lay stress on the importance of passing the drain down to the depths of the abscess cavity (McKenzie [5]). Various forms of drainage are employed; a large drainage tube, gauze packing, cone-shaped wire-mesh drain and so forth.

We believe that this form of operation is satisfactory when the abscess is superficial, but there are serious objections to it in deep-seated abscesses. Everyone who has tried to use this method for deep-seated abscesses will have experienced the great difficulty in getting exposure of the abscess through such a small opening. The œdematous brain overlying the abscess pushes itself into the wound, no matter what form of retraction is used, and rapidly obscures the abscess, which may not be found again. In operations of this type opportunity of inspecting the abscess may be very fleeting and everything has to be done so rapidly (the evacuation of the pus, and insertion of the drainage tube to the bottom of the abscess cavity), that there is no room for the slightest hitch. Just at the moment of exposure of the abscess the depths of the field may be hidden by fresh bleeding from cortical vessels, which have been ruptured by the deeper and stronger retraction that is necessarily though unconsciously made when the abscess is exposed. The method is too hazardous for deep-seated abscesses, though it is probably the method of choice for superficial ones. With this method also it is possible to irrigate the abscess cavity, a procedure employed by Macewen [6] in his conspicuously successful group of cases.

(*b*) *Through an osteoplastic flap.*—Neurological surgeons occasionally come upon a brain abscess when exploring for intracranial tumour by the usual wide osteoplastic exploration. In such cases the abscess is generally a chronic one of fairly long duration and perhaps for that reason these cases often make complete recovery. Nevertheless, one cannot help being impressed with the ease with which an abscess

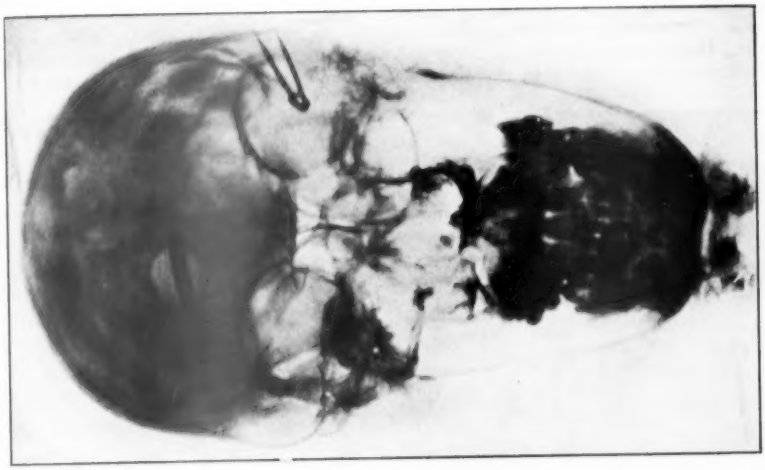


FIG. 8b

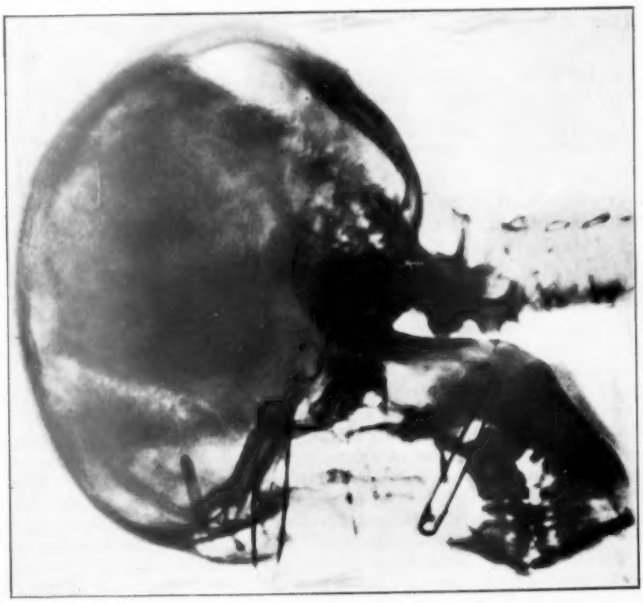


FIG. 8a

FIGS. 8a and 8b. *Case* 3.—Right frontal abscess. Lateral and antero-posterior radiograms showing rubber catheter in the abscess cavity.

cavity can be thoroughly emptied by this method, and with the minimum of trauma to the brain (fig. 9). We have treated four cases by this method; two cases of staphylococcal abscess secondary to inconspicuous infection of the skin and subcutis,[1] one case of streptococcal abscess probably secondary to temporal bone disease and one case of pneumococcal abscess. This last was the only case in which the patient did not recover, and at operation there were found indications that the infection was

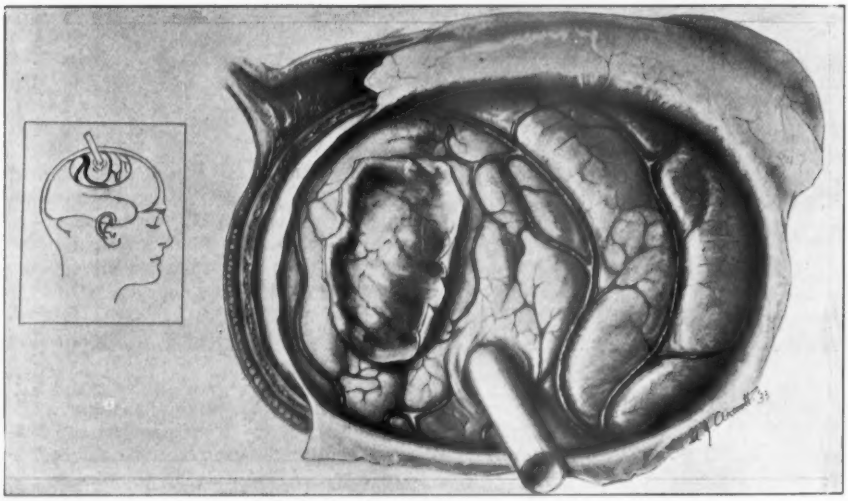


FIG. 9.—Sketch of an osteoplastic operation for subcortical pneumococcal abscess of the right parietal lobe. The drainage-tube passes into the abscess cavity. In front of it and not connected with the abscess there is a focal area of pachy- and lepto-meningitis and here the dura is seen to be firmly adherent to the cortex. The patient died of diffuse pneumococcal infection of the leptomeninges and ventricles three weeks after the abscess was drained.

not localized (fig. 9). The patient died of pneumococcal meningitis three weeks after the abscess was drained. None of the other cases in which the abscess was drained through an osteoplastic flap showed any clinical evidence of meningitis after operation in spite of the fact that in two of them at least there was obvious spread of infection through the field of operation. The following case is an example:—

Case 4: *Staphylococcal abscess of right precentral gyrus.*—I. W., a girl, aged 7, referred by Dr. A. G. Maitland-Jones, had a trivial cut on her right knee and a few weeks later suddenly began to have Jacksonian motor attacks in the left side of the face, violent frontal headaches and vomiting. Four weeks after the onset of these symptoms a right osteoplastic exploration was made and an abscess 3 cm. in diameter was found immediately beneath the surface of the lowest part of the precentral gyrus. The abscess was emptied by suction without any obvious contamination of the operative field, and the cavity was drained through a small incision in the temporal region, the original incision being closed. The pus from the abscess showed *Staphylococcus aureus* in films and cultures.

One week after operation this patient developed *S. aureus* infection along the line of the scalp incision and continued to discharge pus from various points during the next six weeks (fig. 10). She never showed any signs of meningitis and her general condition throughout this time was quite satisfactory.

[1] Since this paper was written another staphylococcal abscess has been successfully treated by the same method.

When an abscess near the surface of the brain is exposed through an osteoplastic flap, or is seen at necropsy, it is usual to find streaks of yellow material in the sulci immediately over and around the abscess, and histological examination shows pus or chronic inflammatory cells, not only in these sulci but also in the perivascular spaces of the white matter around the abscess. There is probably considerable local

FIG. 10. *Case* 4.—The patient after drainage of a staphylococcal abscess of the right precentral gyrus through an osteoplastic flap. The sinuses are the result of staphylococcal infection of the scalp after operation. There were no clinical signs of meningitis.

resistance to the spread of the infecting organism and the leptomeningeal spaces immediately over the abscess are probably sealed off. This appears to us the reason why spreading meningitis is not set up after osteoplastic exploration, though, as we shall see later, infection of the leptomeninges probably does occur in slight degree after every abscess is drained.

AFTER-TREATMENT OF ACUTE AND CHRONIC ABSCESS

Whatever method is employed in treatment of these abscesses, the after-treatment is the same. The patient should be nursed in such a position that gravity assists drainage of the abscess. Dressings, we believe, should be done only at long intervals. We leave the first dressing undisturbed as long as possible, usually about a week, sometimes ten days or even more, only doing the dressing if some complication ensues, or if the patient is becoming uncomfortable because of the discharge.

Case 5.—*Left frontal abscess after localized acute osteomyelitis of frontal bone.*—S. H., a boy, aged 13, was struck on the right side of the forehead by a cricket ball and six weeks later developed a tender swelling on the forehead just to the right of the middle line, accompanied by fever, headache and vomiting. At operation the swelling was found to be an area of osteomyelitis with extradural and sub-pericranial pus around it. This was drained. He gradually developed signs of left frontal abscess and this was drained by a rubber catheter about seven weeks after the first operation.

The first dressing was done eight days after the abscess had been drained (fig. 7), the second on the fourteenth day, the third on the twenty-ninth day, the fourth on the forty-sixth day and the tube was finally removed on the sixty-first day.

It is necessary to add that dressings are only left for such a long time if the clinical condition of the patient is satisfactory. The point that we wish to emphasize is that when a tube is well placed in an abscess, daily dressing and manipulation of the tube probably does more harm than good.

Dressings are done in the operating theatre, and by the surgeon who performed the operation, and they often take one-half or three-quarters of an hour to do. The tube is not removed, except when intracranial pressure suddenly pushes it out as the dressings are removed, and this we try to avoid. It is left in as long as possible and is gradually shortened.

The next important factor in after-treatment of brain abscess is prolonged rest in bed. It is a wise measure to keep a patient who has had an operation for brain abscess in bed for several weeks after operation, if possible, and to keep him very quiet and under fairly close observation for a period of three months.

Material

Excluding abscesses secondary to bronchiectasis, which constitute a different problem and with which we have only had one temporary recovery in ten cases, our material is as follows :—

Table.

Source	Total cases	Died	Cases operated on	Recovered
Pyæmia from skin and subcutis	3	1	3	2
Direct infection (G.S.W. 2, Rodent ulcer 1) ...	3	2	3	1
Osteomyelitis of skull	5	2	5	3
Frontal sinus	4	3	3	1
Sphenoidal sinus and nose	2	2	2	—
Middle ear and mastoid	13	10	7	3
Totals	30	20	23	10

It would not be profitable to analyse this material in detail, for various reasons. Several of the cases operated on were in a hopeless state at the time. In two, for example, operation was performed under artificial respiration. On the other hand, mistakes of diagnosis should count in mortality rate just as much as mistakes of operative treatment, but there was too much divided responsibility in this group of cases to allow of that being accurately assessed. The main value of the figures is to give an idea of how bad the results are and to show how much room there is for improvement in diagnosis.

Post-operative Complications

In this section we consider the complications that occurred in the cases that recovered. They may be so disturbing as to result in further and unnecessary surgical interference.

Rise of temperature is usual. Whereas in the pre-operative course the temperature is often subnormal, after operation it shows an irregular rise up to 102° F., and this may persist for up to three weeks (fig. 11).

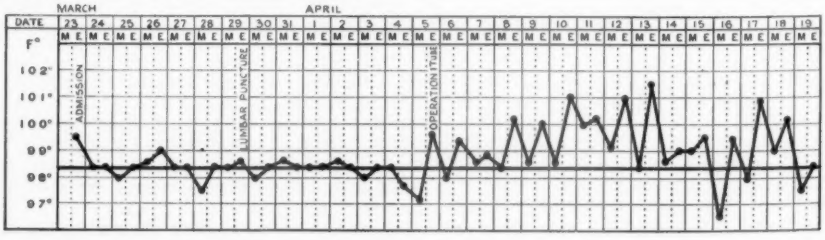


Fig. 11. *Case* 4.—Temperature before and after drainage of a staphylococcal abscess of right precentral gyrus.

Œdema and meningitis.—These two conditions are here grouped together because they both probably play a part in the recurrence of symptoms that occasionally follows temporary improvement after operation. An abscess is drained and there is prompt improvement in the general condition of the patient and in the local symptoms, but after a day or more the local symptoms become again severe, the temperature rises and the patient lapses into stupor.

These symptoms are probably due to increase of local œdema after the abscess has been drained. Before operation œdema is always present in the white matter around a brain abscess, sometimes to such an extent as to produce false localizing signs (fig. 12). The white matter around the abscess is soft and glistening, and histological sections show that it contains many clear spaces. The extent to which brain swelling, presumably œdema, may increase after drainage of an abscess is shown by the following case:—

Case 6. *Left temporal abscess.*—W. M., aged 17, referred by Dr. George Riddoch, was operated on on January 15, 1929, for an expanding lesion in the left temporal lobe, of which the predominant symptoms were headache, vomiting, slight confusion and Witzelsucht, and slight nominal aphasia. An osteoplastic flap was turned and a large abscess (*Staphylococcus aureus*) was found 1·5 cm. beneath the surface of the anterior half of the left temporal lobe, surrounded by a firm capsule, 0·1 to 0·2 cm. in width. The abscess was emptied and was drained through a stab incision in the temporal region; the bone flap was replaced and the wound was closed.

After the operation the patient was drowsy and restless, and after twenty-four hours he had a convulsive seizure beginning with clonic movements in the right arm and leg. He failed to recover consciousness, his respirations became slow and laboured, and the flap was very tense. It was feared that he might have post-operative extradural clot, but when the flap was re-elevated thirty-five hours after the first operation very little clot was found. The swelling was due to diffuse bulging of the brain. The abscess cavity was empty. After this operation there was prompt recovery.

This case was rather unusual because the symptoms of œdema came on immediately after operation, but it is cited because the symptoms were so clearly shown to be due to swelling of the brain. More commonly the symptoms of œdema come on somewhat later, as in the following case, seen by one of us in consultation with Mr. Donald Wheeler:—

Case 7.—The patient was a boy of 14 who was drowsy and dysphasic. On April 28, 1929, Mr. Wheeler drained a large subcortical abscess in the left temporal lobe. On the following day the patient was much better; his pulse-rate had risen from 65 to 76, he was more alert and his dysphasia had practically disappeared. On April 30 he became again very drowsy and dysphasic, his temperature rose to 102, and his pulse-rate slowed to between 60 and 70. He remained in this condition until May 3, when he was more alert and co-operative though still showing considerable dysphasia. The temperature did not become normal and the pulse-rate did not rise again to 76 until May 12, by which time his speech was greatly improved, though he still had some nominal aphasia and dyslexia. Throughout the period of drowsiness both before and after operation there was considerable rigidity of the neck.

When symptoms recurred after operation the drainage tube in the abscess was manipulated; but neither then nor at any time later was there any large amount of purulent discharge. The patient made a quick recovery and by May 30 there was no trace of aphasia except for slowness in reading aloud.

A lumbar puncture was carried out before operation in this case and the cerebrospinal fluid was found to be turbid. No cytological or bacteriological examination was made. During the post-operative period no further lumbar punctures were done, but it is to be noted that rigidity of the neck, which was present before operation, persisted throughout the period of drowsiness.

The nature and cause of post-operative œdema after drainage of brain abscess are obscure. At necropsy the white matter around a brain abscess frequently contains

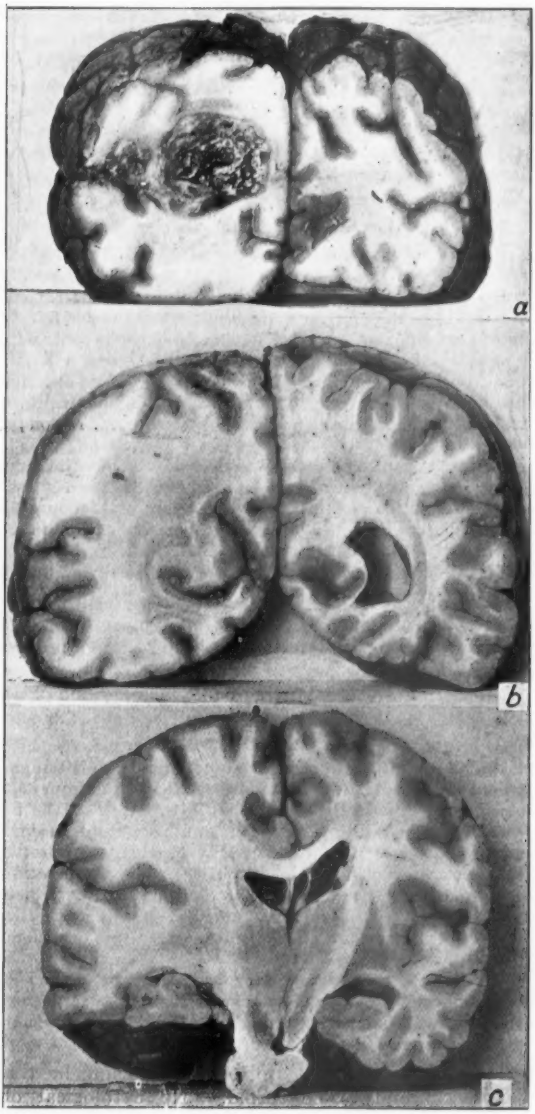


FIG. 12.—Œdema of the brain secondary to a staphylococcal abscess of the left occipital lobe (*a*). The swelling of the white matter of the left hemisphere (*b*, *c*) extended forwards into the frontal lobe. The occipital abscess was drained but the pus was very thick and the abscess did not empty. Subsequently the patient developed considerable weakness and spasticity of the right arm and leg and a grasp reflex in the right hand. The left frontal lobe was explored for a second abscess with negative result.

an excess of watery fluid between the nerve-fibres, visible not only in histological sections but sometimes to the naked eye. In fatal cases the white matter around an abscess is often broken up by collections of this fluid in a way that suggests that these may form the starting point for fresh abscesses. When draining an abscess it is a common observation that the flow of pus is followed by escape of turbid watery fluid, and the operator fears that there has been rupture of the ventricular wall. But we have direct observations that this fluid does not come from the ventricle but from the abscess wall by a process of generalized exudation. Thus in the fatal case of pneumococcal right parietal abscess already described (fig. 9), during the hour that followed complete emptying of the abscess cavity by suction, turbid watery fluid dripped from the drainage tube in the abscess. This abscess was a long way from the ventricle which at necropsy was seen to be intact. From our observations we are forced to the conclusion that there is an active circulation of fluid in the white matter around brain abscesses. The fluid under certain circumstances may pass rapidly into the abscess cavity, while in other cases, as in post-operative œdema, it may accumulate in large amount in the white matter.

It is possible that post-operative œdema may be wholly or partly caused by spread of infection in the meninges and brain itself at the time when the abscess is drained. Spreading meningitis can exist without any of the classical signs of meningitis and we believe that a certain amount of meningitis probably always occurs after an abscess has been drained, but that it does not always give recognizable clinical signs. The only way that it can be recognized is by day-to-day study of the spinal fluid, and the surgeon is not unnaturally averse to daily lumbar punctures after he has drained an abscess.

[Since this paper was written, observations of this nature have been made by us in a case of right prefrontal abscess secondary to boils on the face three months before. The abscess was encountered after an osteoplastic flap had been turned, and was removed with its capsule. During removal the abscess wall ruptured slightly at one point and a little of the contained pus escaped. After operation lumbar punctures were done at frequent intervals to see whether any meningitis had occurred. On the first day after operation the cerebrospinal fluid contained 57 cells per c.mm.; on the second and again on the fourth day 200 cells, on the sixth day 1,400 cells, on the ninth day 150 cells, on the fourteenth day 100 cells, on the twentieth day 56 cells, on the twenty-sixth day 10 cells. There were no constitutional signs of meningitis during this period. Before operation there was only slight weakness of dorsiflexion of the left hand. Left hemiparesis developed slowly in the first few days after operation and gradually cleared up completely, its degree varying approximately with the degree of pleocytosis of the spinal fluid.]

Whatever the cause of the œdema, it is clear that it should not be treated by further surgical intervention. When symptoms recur during the first day or so after an abscess has been drained, the surgeon is apt to think that the drainage tube has become blocked, and often proceeds to manipulate it or to replace it by another tube, without recovering a significant amount of pus. If at operation the tube has been satisfactorily placed in the abscess cavity and the abscess has thereupon been emptied, it is probably better not to interfere if symptoms of œdema arise.

Squint.—Squint and double vision may come on after a brain abscess has been satisfactorily drained. Thus in a case of right frontal abscess (Case 3) a right third-nerve palsy was found when the right eye was first uncovered on the tenth day after operation. Sixteen days later this had practically cleared up, though ptosis of the right upper eyelid persisted for several months. This third-nerve palsy occurred at a time when the rise of intracranial pressure had been relieved, and it persisted in slight degree for much longer than it would have done if it had been due to rise of intracranial pressure. The most likely explanation is that it was due to a patch of fibrino-purulent material in the cisterna interpeduncularis on the right third nerve. Similar, and to the naked eye isolated, areas of fibrino-purulent material have been

observed in the basal cisterns at necropsy in other cases, where death has been caused by rise of intracranial pressure rather than by generalized meningitis. This explanation is in accord with our more recent observations on the occurrence of slight lepto-meningitis after an abscess has been drained.

Incomplete drainage.—In the more severe infections incomplete drainage of an abscess may prove fatal, but that it is not always so is shown by the following case:—

Case 8.—Bronchopneumonia. Local osteomyelitis and extradural abscess of right parietal region. Subcortical abscess of left parietal lobe (cultures sterile). Three operations for drainage of brain abscess. Recovery.—A. B., a male aged 28, referred by Dr. Robert Hutchison, fell ill with bronchopneumonia on December 15, 1928.

December 28: An abscess developed on the sole of the right foot and was opened. The pus was sterile on culture, but films showed Gram-positive cocci.

January 5, 1929: An abscess appeared in the neck, but it subsided in the next two weeks without being opened.

January 20: The patient began to have frontal headaches.

January 25: A swelling appeared in the right parietal region.

January 31: There were sensory and motor attacks of Jacksonian epilepsy beginning, it was said, in the right upper limb and at times spreading to the right and, to a less extent, the left lower limb. There was no loss of consciousness. Examination showed disturbance of postural sensibility in the right big toe and, to a slight extent, in the right thumb. The plantar reflex on the right side was doubtfully extensor.

First operation.—January 31: The right parietal swelling was explored and a sequestrum removed, and an extradural abscess was drained. This did not spread across to the left, but stopped 1 cm. to the right of the middle line. After this operation there was complete relief from headache, and neurological examination showed none of the signs observed after the epileptic attack on January 31.

February 13: Headache in the last two days. This morning he had a Jacksonian seizure without loss of consciousness which began with "pins and needles" and twitching in the right leg, and was followed by temporary paralysis of the right upper and lower limbs.

February 19: Headache worse. Vomiting. Slight hemiparesis and severe loss of postural sensibility in the right arm and leg.

Second operation.—February 19: Drainage of subcortical left parietal abscess, 2·5 cm. below the dura, by rubber catheter. About 5 c.c. of thick pus only were obtained.

February 24: Vomiting. Drowsy. Almost complete paralysis of left external rectus. Right hemiparesis now complete in the leg and much worse in the arm. Analgesia to pin over right half of body.

Third operation.—February 25: Further exploration of left parietal lobe by brain needle. Abscess not found.

February 28: Slight recovery of voluntary power in right leg. Still very severe postural loss on the right side.

March 20: About 4 c.c. of pus escaped from skin incision in left parietal region.

March 24: Power in right arm began to recover.

April 1: Recurrence of headache and vomiting. Right hemiparesis again practically complete. Right-sided sensory loss as before. Dysarthria. Slight papillœdema.

Fourth operation.—April 2: Subcortical abscess of left parietal lobe drained. Evacuation of 30 c.c. of thick greenish-yellow pus. Drainage of abscess cavity by catheter.

April 9: Great improvement in power of right side. Slight recovery of postural sensibility at right ankle. An attack of Jacksonian epilepsy beginning in right foot.

May 9: Walking with assistance.

May 27: Discharged from hospital. External rectus weakness has practically disappeared. Slight weakness and spasticity of right arm and leg. Defect of postural sensibility, slight in right hand, considerable in right foot.

July: Returned to work.

March, 1934: Regularly at work as a labourer. Turns right foot inwards a little as he walks, but no other disturbance of power. Defect of postural sensibility, very slight in right thumb, slight in right big toe.

In this case the left parietal lobe was explored three times before the abscess was satisfactorily drained. It is probably only on account of the low intensity of the infection that this was possible. Although there was practically complete hemiplegia and very severe sensory loss on the right side for more than five weeks the ultimate recovery of function was nearly perfect.

Recurrence.—Recurrence of an abscess after a long interval may be the result of incomplete drainage. It often means that the abscess is multilocular, owing to injury of the capsule of the primary abscess either at the original operation or from partial rupture into the surrounding white matter owing to tension of its contents.

Case 9.—*Recurring left temporal abscess.*

First admission.—G. C., aged 29, was admitted to the London Hospital under the care of Mr. Muecke, on April 25, 1928. He had suffered for six years from discharge from the left ear and he sought treatment on account of a polyp which was protruding from the left ear.

First operation.—April 27, 1928: An incomplete mastoidectomy was performed on the left side.

Second operation.—May 22: A left temporal abscess was opened and drained. Exposure of the abscess was difficult and drainage was incomplete.

Third operation.—July 5: Owing to recurrence of symptoms the wound was reopened and an extradural abscess was drained. The brain was not explored.

Fourth operation.—July 27: The abscess was thoroughly drained after its stalk had been mobilized. He was discharged from hospital on September 2, 1928.

Second admission.—He was readmitted on August 17, 1929, on account of headache and nausea.

Fifth operation.—August 27, 1929: A left temporal abscess was drained and most of its capsule was dissected out. The wound healed quickly but right upper quadrantic hemianopia persisted, and early in October he developed again other local signs of a left temporal abscess.

Sixth operation.—October 13: A large posterior left temporal abscess was emptied and drained. It had a thin capsule and lay behind a fibrous mass at the site of the previous operation. It was evidently a different abscess from the one which had been treated at the previous operation.

He was discharged from hospital on November 11, 1929, free from symptoms but still showing right upper quadrantic homonymous hemianopia.

From the end of 1928 onwards, that is after the fourth operation, he had suffered from occasional generalized convulsions and from a discharge of cerebrospinal fluid from a pin-point opening in the lower part of the mastoidectomy incision.

Third admission.—In an attempt to relieve these symptoms he was admitted once more to hospital.

Seventh operation.—January 23, 1930: The tough yellowish-white remnants of the old abscesses in the left temporal lobe, forming a mass about 2 cm. in diameter, were exposed and in the process the left lateral ventricle was widely opened. A track lined by dura was found passing through a small hole in the anterior surface of the temporal bone medial to the limits of the previous mastoidectomy. This track was excised.

This operation was unsuccessful, for both the fits and the occasional leakage of cerebrospinal fluid persisted, as did the right upper homonymous hemianopia. In other respects the patient was well and free from symptoms and he remained thus during the ensuing four years, up to the time of this report.

The details of this case-history have been omitted in order to conserve space. There is little doubt that recurrence of the abscess in this case was due to imperfect drainage at the first operation, when the brain overlying the abscess was also injured in attempts to get the abscess exposed. The persistent cerebrospinal fistula also calls for comment. We have not seen it in any other case.

Imperfect drainage is probably not the only cause of recurrence. Persistence of the original focus of infection must doubtless at times play a part. Thus we have had one case of subcortical abscess of the centrum semi-ovale secondary to bronchiectasis, in which the abscess was very satisfactorily drained at operation; five

months later, however, there was a recurrence at the site of the former operation. This rapidly spread to the ventricle without attaining any considerable size and the patient died from generalized leptomeningitis.

The cases in which recurrence of abscess is most to be feared are those in which neurological signs still persist to any extent. For example, we have under observation at present a young woman in whom we found and drained an abscess of the right occipital lobe in August 1932. Drainage of the abscess was complete and her subsequent course was satisfactory and she has been at work since November 1932, without symptoms. Before operation she had complete homonymous hemianopia. Nine days after operation the right upper quadrants of the fields began to recover and eventually regained normal vision, but there has never been any recovery in the lower quadrants. This lack of recovery probably indicates scar

FIG. 13.—Encephalogram showing traction diverticulum of frontal horn of left lateral ventricle at site of old brain abscess.

tissue and where there is scar tissue there are likely to be areas of pus cells from which recurrence might take place later.

Epilepsy.—Fits occurred during the first few weeks after operation in four of the 10 patients who recovered, but in only one of them did the fits continue after the patient left hospital. This patient (Case 9) has been subject to fits ever since his abscess was drained, in spite of the fact that the scar tissue resulting from the abscess was radically excised down into the lateral ventricle.

We have also studied a further case of epilepsy following frontal abscess in which the original operation for left frontal abscess had been carried out elsewhere seven years before. Epilepsy began immediately after the patient had recovered from the abscess and consisted of dreamy attacks associated with hallucinations

of smell which occurred daily, and attacks of falling without warning, which completely interfered with his work. When he came under our care he had evidence of intense scarring at the site of the old abscess with a traction diverticulum of the frontal horn of the left lateral ventricle (fig. 13). Free excision of the left frontal pole failed to relieve his fits.

Mistakes in Diagnosis and Treatment

In certain cases, owing to the intensity of the infection and low resistance of the patient, the chances of a successful result from surgical treatment are probably extremely poor from the very beginning. Thus, cases in which the pus shows a free and abundant growth of bacteria, and cases in which most of the accessory sinuses are heavily infected fall into this group. But there are many cases in which death is due not so much to the inability of the patient to localize and limit the infection as to our inability to find and deal adequately with the abscess. Undoubtedly the greater number of failures of this type are due to mistakes in diagnosis, but we will first consider errors of treatment.

Errors of Treatment

Assuming that the surgeon approaches an operation for brain abscess with a clear idea of how abscesses of varying types should be drained, and that he is reasonably gentle in his handling of the brain, the mistakes that he can make in treatment are relatively few. For, though after a death in a case of brain abscess he may feel that some detail has been responsible for a bad result, yet in the light of the post-mortem examination and later reflection this often proves to have been false. If an abscess has been operated on at the right time and the right type of operation has been done there is a good chance of recovery.

(1) *The wrong type of operation is performed.* — Thick-walled multilocular abscesses cannot be treated satisfactorily by drainage but require dissection and total removal, or marsupialization. Abscesses in which the pus is very thick are probably best treated through an osteoplastic flap.

(2) *The abscess is missed with the exploring needle.*—This happened in one of our cases of chronic recurrent frontal abscess in which the correct diagnosis was made. At necropsy the abscess was a thick-walled abscess containing a little thick pus, and it was so low in the frontal lobe that its capsule presented on the inferior surface of the brain. The patient was comatose from cerebral œdema at the time when he came into hospital, and there is little doubt that the only possible chance of success would have been an immediate osteoplastic exploration with dissection of the abscess and a wide decompression. If the abscess had been found with the exploring needle, the major operation would probably have been performed.

In one of our cases treated by an osteoplastic flap the exploring needle entered the abscess cavity but no pus escaped. When the needle was withdrawn a plug of fibrino-purulent material was found in its eye. The material in a needle after exploratory puncture of the brain always repays examination.

(3) *The tube is blocked.*—Coleman considers that pus can usually escape around the sides of a blocked tube, but in one of our cases of frontal abscess blockage of the tube undoubtedly contributed to the patient's death. Gauze became plugged against the opening of the tube. It is preferable to cover the drainage tube with sheet guttapercha which will not stick.

(4) *Oblique drainage.*—Abscesses that are drained obliquely, instead of at right angles to the skull at the point where the abscess is nearest the surface, do not drain satisfactorily.

(5) *Operation too early* will produce an unfavourable result in a case that otherwise might end well if operation was delayed until a capsule formed. Thus in a patient with a streptococcal frontal abscess following infection of the maxillary

antrum and sphenoidal sinus, the abscess was drained ten days after headache began. No capsule could be felt. The pus was quite fluid but rather thick, and it was blood-stained. The abscess was emptied easily of about 2 oz. of pus, and the catheter was lying nicely in the cavity. On the fourth day after operation at the first dressing twisting of the tube produced about ½ to 1 oz. of pus. The patient appeared to be making a good recovery, but on the seventh day after operation she began to be irritable and developed signs of meningitis from which she died three days later. At necropsy the track for drainage of the abscess was found to be freely open, and the abscess was partially collapsed, but nevertheless there was a perforation (0·3 cm. in diameter) from the posterior part of the abscess into the frontal horn of the lateral ventricle, and there was severe pyocephalus and diffuse lepto-meningitis. It should be noted that this perforation occurred in the posterior wall of the abscess which was never interfered with or injured during operation. There was very severe œdema of the white matter around the abscess.

There is no doubt that cerebrospinal fluid is continually leaking through the abscess wall from the surrounding white matter. One would expect it to wash out the infection and to promote recovery from the infection. But, if the infection is not yet limited and walled off, drainage of the abscess seems to increase the œdema of the surrounding white matter and the infection can then spread through the brain more easily, with the result that fresh abscesses form in the surrounding white matter, or infection spreads into the lateral ventricle.

(6) *Œdema* of the white matter around abscesses is little understood and provides a problem in treatment not only in this type of case but also in many cases of intracranial tumour.

(7) *Errors of nursing.*—Cases can be lost as a result of imperfect nursing care after operation, especially care about swallowing. This is a continual anxiety in all intracranial surgery. The patient who is drowsy and whose swallowing and cough reflexes are depressed is very apt to get fluid nourishment into his trachea, with resultant bronchopneumonia and purulent bronchiectasis. In one of our fatal cases in which there was an abscess in each frontal lobe, bronchopneumonia undoubtedly contributed to the fatal issue.

Mistakes in Diagnosis

There is often, to be sure, very little time in which to make the diagnosis, as the following case shows :—

Case 10.—W. B., aged 20, was admitted to hospital in coma. Since childhood he had had purulent discharge from the left ear. Three weeks before admission he caught cold and one week before admission he had acute pain in the left ear and copious discharge from it. Two days before admission he went to the cinema and on the following day he was walking about and, according to his parents, had no complaints. On the morning of admission he got up, walked a few steps and complained of weakness. He went back to bed and within half an hour became unconscious.

On examination he was deeply unconscious and had marked rigidity of the neck. There was a purulent discharge from the left ear. The right upper limb was spastic and both plantar reflexes were extensor. Lumbar puncture yielded slightly turbid fluid containing 200 white cells per c.mm., and 0·1% of protein. Cultures were sterile. 8 c.c. of fluid were withdrawn.

Six hours after admission his breathing became bubbly and laboured and he died soon afterwards. Necropsy showed a chronic left temporal abscess with slight localized lepto-meningitis over it.

There was, we believe, a mistake in the management of this case to which we will have occasion to refer to shortly. But apart from that, the course of the illness was extremely rapid. We have seen other cases almost as rapid. Abscesses with such a rapid course are almost invariably of much longer duration than the history indicates and if the history could be obtained in detail (patients like this one are

usually poor and uneducated) we would get a story of previous headache, drowsiness and perhaps shivering, indicating either that the patient had at some former time had a cerebral abscess which subsided spontaneously, or that the initial infection had occurred some weeks before the illness appeared to begin. From post-mortem studies in our series there is no doubt that a cerebral abscess can subside spontaneously and another abscess can subsequently form rapidly at the same site.

Going through our cases we find many errors of diagnosis, mostly committed by ourselves.

(1) *Cases in which the diagnosis of brain abscess has been completely missed.*—These are the cases in which infection of the middle ear, mastoid or accessory sinuses is, or appears to be, insignificant. Such patients are admitted to the medical wards. Formerly they were often diagnosed as suffering from cerebral thrombosis or encephalitis. Recently in our experience there have been less mistakes of this type in diagnosis, though one of our patients was admitted as suffering from typhoid fever.

These cases merely serve to emphasize how slight may be the headache in brain abscess. Headache may be prominent in the picture at the onset of the abscess, and then may be completely superseded by a state of drowsiness and lethargy, which often does not arouse a feeling of anxiety among the nurses and doctors who are watching the patient. In this group mistakes sometimes arose out of the notion that absence of papillœdema excludes a diagnosis of abscess. It cannot be too widely known that while some patients develop papillœdema, many of the worst cases show little or no swelling of the discs at all.

(2) *Cases in which cerebral abscess is suspected but not diagnosed in time, or the diagnosis of cerebral abscess is rejected for some other.*—In this group many mistakes arise out of insufficient knowledge of the variations in cellular content of the cerebrospinal fluid in brain abscess. A patient becomes drowsy and complains of headache after otitis media ; a lumbar puncture shows purulent cerebrospinal fluid with cell counts of anything up to 1000 per c.mm. The bacteriologist reports organisms also in direct films of the cerebrospinal fluid and a diagnosis of generalized leptomeningitis is promptly made, though subsequently cultures of the cerebrospinal fluid are found to be sterile. In the meantime, drainage of the cerebrospinal spaces by lumbar puncture has been started, a procedure that almost invariably hastens the end if the patient has a brain abscess. High cell-counts in the cerebrospinal fluid are not infrequently found in abscess, especially abscess of the cerebellum, although there is is no generalized meningitis.

Diagnosis between general leptomeningitis and cerebral or cerebellar abscess may at times be very difficult, for cases occur in which both these varieties of infection are present before any intracranial operation has been done. But, as a rule, a careful history and neurological examination should enable us to distinguish between the two. It is important not to be put off a diagnosis of abscess by finding turbid cerebrospinal fluid in which are organisms and excess of protein. Abscesses may leak into the lateral ventricles or subarachnoid space without producing fatal diffuse leptomeningitis.

In some of our cases a diagnosis of abscess has been rejected because there was no increase of cells in the cerebrospinal fluid. In one case of abscess of one cerebral hemisphere the cell count and protein content of the spinal fluid were normal (Case 4). This, it must be noted, was a case in which the infection of the brain was by the blood-stream. We have not seen a cerebellar abscess without increase of cells in the cerebrospinal fluid. In another case the diagnosis between tumour and abscess of the left temporal lobe was made in favour of tumour because the cells, some thirty per c.mm., were all lymphocytes. Necropsy later showed an abscess.

While it is clear that more knowledge is needed about the variations of the cerebrospinal fluid in brain abscess, it should at the same time be emphasized that lumbar puncture may be a most dangerous form of investigation if much fluid is

allowed to escape. We have seen several cases in which sudden death occurred soon after the withdrawal of 10 c.c. of cerebrospinal fluid at a diagnostic lumbar puncture, for example, Case 10. Only 0·5 to 1 c.c. of fluid should be taken. This will give all the information that is required and will not upset the patient.

Before leaving this question of the diagnosis between abscess and generalized leptomeningitis it must be noted that diffuse leptomeningitis after middle-ear and mastoid disease may sometimes evolve so slowly as to simulate abscess of the brain, and may also show focal signs such as are found in abscess. The diagnosis is apt to be especially difficult if infection of the labyrinth has also occurred. Purulent pachymeningitis after frontal sinus infection may also simulate abscess though usually the clinical picture of this condition is quite distinct (Cairns [7]). When there is difficulty an exploratory tapping and ventricular estimation is justified.

Exploratory tapping.—This has been referred to in a previous communication before this Section [7], and it is only necessary to remind you that it will be especially valuable where the abscess is suspected to be in one or other cerebral hemisphere. The ventricle is always collapsed on the side of an abscess and is normal, or slightly larger than normal, on the opposite side. If made through a clean incision such an exploration is not harmful, but in the event of a positive result the abscess should be drained immediately, otherwise diagnostic tapping is likely to be followed by the same consequences that may attend withdrawal of cerebrospinal fluid by lumbar puncture. This method is also useful for distinguishing between patients with abscess and patients with tuberculous meningitis or meningo-encephalitis who happen to have a running ear.

In the chronic cases of abscess it is often difficult to make a differential diagnosis from tumour. As already described, in four of our cases an osteoplastic flap was turned. In three of the four cases abscess was considered as a possible diagnosis. In only one of the cases was there a history of middle-ear disease and even in that case the cause of the abscess was not certain. The difficulties of diagnosis are increased by the fact that we occasionally find tumours where abscesses have been suspected. One patient with a left frontal glioma had fairly severe left otitis media; another patient whose illness began after influenza and a discharging ear proved to have a subdural hæmatoma.

Another type of case in which diagnosis of intracerebral abscess may be at fault is that in which at operation an extradural or subdural abscess is found and is thought to be sufficient to account for the symptoms, and the brain is not explored. The difficulty here is enhanced by the fact that extradural suppuration can produce cerebral symptoms.[1] It might be considered that this is an error of treatment but we believe it to be an error of diagnosis. Is there anything observable at operation from which it can be foretold that a patient with an extradural abscess has or has not also an intracerebral abscess? Is it not rather a question of accurate diagnosis from thorough examination before operation begins? From limited experience we would expect that with further study, extradural and intracerebral abscesses could be differentiated clinically.

Lateral sinus thrombosis also gives rise to difficulties, especially as it is commonly associated with cerebellar and cerebral abscess.

(3) *Cerebral abscess is diagnosed but not accurately localized.*—We have nothing to add to the classic description of Symonds [8] of the localizing signs of brain abscess. These signs cannot always be demonstrated when the patient is drowsy or unconscious and then precise localization of the abscess may be very difficult as in a case which we saw recently for Mr. Norman Patterson.

The patient was a girl, aged 8 years, who had had a discharging left ear since infancy. Some weeks after tonsillectomy she suffered acute pain in the left ear and the discharge stopped, and this was followed by headache, drowsiness and vomiting. An incomplete

[1] We have even observed a case of orbital abscess for some time as a probable case of intracerebral abscess.

mastoidectomy was done: when we saw her three weeks later she had signs of a cerebral abscess. She was drowsy and uncoöperative, and her visual fields could not be examined but there were signs indicating clearly that the left cerebral hemisphere was involved: weakness of right side of the face and of the right upper limb, diminished abdominal reflexes and at times an extensor plantar response on the right side. It was concluded that there was a right temporal abscess, but exploration of the temporal lobe was negative. The child died and at necropsy a large abscess was found in the left frontal lobe. There was pus in the left frontal sinus, also a sequestrum which would probably have shown in postero-anterior skiagrams of the skull.

Accurate localization of an abscess like this, when a patient is not seen until stupor has set in, is practically impossible and the surgeon should always keep an open mind about the possibility of the abscess being in an unusual place and should make such preparation before operation that he is able to explore more widely without disturbing the operative field. Evans found among 109 cases of brain abscess secondary to otitis media and mastoiditis 6 in which the abscess was not

FIG. 14.—Cerebellar abscess, secondary to infection of right middle ear and mastoid, in an unusual situation in the upper part of the vermis.

temporal but occipital, parietal or frontal. In an unconscious patient one must be prepared to explore in more than one area.

In one case we failed to find a cerebellar abscess through exploring in the wrong place. The patient was in an advanced stage of stupor and obviously had a cerebellar abscess, but exploration failed to find it in the usual place. At necropsy the abscess was found high up in the vermis, strictly in the middle line (fig. 14).

In this group must be included those cases in which only one of multiple abscesses is drained. We have had several cases of this type following bronchiectasis and only one from other causes, a case of bifrontal abscesses both of which were drained. However, brain abscesses may be multiple after middle-ear and mastoid infection (7 out of 109 cases, Evans), especially a temporal and cerebellar abscess together after lateral sinus thrombosis.

Œdema of the brain, which so commonly accompanies cerebral abscess, may interfere with localization. One of our cases of occipital abscess gave symptoms of disturbance of the corresponding frontal lobe and these led subsequently to

exploration of the frontal region for abscess (fig. 12). In a case of right frontal abscess the patient had an intermittent complete left homonymous hemianopia which resulted in the first tap being made in the temporal lobe, though the second tap over the frontal region at the same operation revealed pus.

(4) *Other infective foci are overlooked.*—Many of these patients, especially those with frontal abscesses, have multiple sinus infections, and the success of treatment of the intracranial infection must surely be hampered if there is still pus in the sphenoidal sinus or antrum of Highmore.

Conclusions

How are we to overcome these many difficulties of diagnosis? Many of them will be overcome by careful history-taking and neurological examination in the light of an accurate knowledge of the life-history of brain abscess. If every patient who has severe headache after ear trouble or mastoid operation were put through the mill of such an investigation the bad results of to-day would be improved. We would especially stress the importance of examining the visual fields. It is that part of the examination more than any other that cannot be done when the patient becomes lethargic and for want of which localization of the abscess in the stuporous patient may be so baffling. When intracranial complications are suspected neurological investigation should take precedence over mastoidectomy, since it will tell more about what is happening inside the dura than can be learned from looking at a small area of dura exposed in the mastoid region. Lumbar puncture should be done, but only 1 c.c. of fluid should be withdrawn. Diagnostic exploration as described is important in certain cases.

With each case of abscess there is need to form some estimate of when the abscess began and what stage it has reached, for this is the only way in which to gauge the right moment for interference. This can only be done by careful study of the history of illness.

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II.—**Mr. Sydney Scott**: To Sir Charles Ballance we are indebted for a full history of the treatment of otitic brain abscess.[1]

For many centuries the association of brain abscess with aural suppuration was generally regarded as purely incidental, though Hippocrates knew of the dangers threatening the brain in ear diseases.

Morgagni, to whom the medicine of the eighteenth century was richly indebted, was one of the first to show clearly that aural suppuration was the primary disease, and that brain abscess was secondary. Previously even Valsalva regarded the brain abscess as primary, though Bonetus stressed the significance of abundant discharge from the ear or from a "fistula" in cases of brain abscess, as being a sign of good omen.

1 Ballance, "The Surgery of the Temporal Bone," London, 1919.

The First Successful Case

Morand published the first case of successful operation for otitic brain abscess in Paris in 1768 (" Opuscules de Chirurgie," p. 161).

This was the case of a monk aged 51, who in 1751 had otorrhœa and then a mastoid abscess which Morand opened. A sinus persisted and was repeatedly treated with the actual cautery : bony sequestra were removed exposing the dura mater. Eventually a T-shaped incision was made, and the sinus enlarged, exposing more dura mater. As pus continued to escape, a probe was passed fully one inch into the brain, and catgut tents were inserted into the cavity to dilate the aperture. Then a crucial incision was made through the dura and Morand introduced the tip of his finger into the brain ; on withdrawing it pus followed. The abscess cavity was irrigated with barley water, with a little turpentine and balsam, which the patient disliked but got used to! As the discharge persisted, more than a teaspoonful coming away at each dressing, Morand had a silver tube made, rather more than one inch long, and as large as an ordinary quill pen. No difficulty occurred after this, and the abscess healed as the tube was gradually shortened and finally removed.

The patient recovered and remained cured, but Morand did not publish the case until he had waited four and a half years to make sure that the cure was permanent.

As Sir Charles Ballance says, in reference to this case, Morand owed his success to his perseverance and determination to establish free drainage.

Early Monographs on Brain Abscess

A hundred years later, Lebert wrote the first systematic account of brain abscess (1856), based on 80 records, 15 from the eighteenth century and five of his own.

Lebert overlooked Morand's successful case and also those of Roux, when he said that no case of recovery was known, and strangely enough cast ridicule upon any attempt at surgical treatment. He said :—

" We must speak more decisively against any attempt at operation, for opening a brain abscess is, even from the theoretical point of view, not rational."

He styles it a " foolhardy procedure."

As has happened many times, the pessimistic conclusions of one writer stimulate another to reinvestigate. William Gull, when assistant physician at Guy's Hospital, made a study of brain abscess, with painstaking observations and sound reasoning. In *Guy's Hospital Reports*, Third Series, 1857, iii, 261, Gull mentioned Abercrombie's review of a series of cases published principally to establish the fact that abscesses are met with in the brain. Gull recognized the " metastatic abscess " secondary to some primary disease in the lungs or elsewhere. He commented on the fact of the latency of brain abscess, and pointed out that :—

" A person may perform all his duties and be in apparently good health, though for many months he may have a large abscess in the cerebrum (Case XIII) " *loc. cit.*

These papers must have stimulated their colleagues to be on the watch for brain abscess, hoping that surgery, if given the opportunity, might bring relief.

In 1877 Erichson wrote that few surgeons would have the hardihood of Dupuytren, to plunge a bistoury into the substance of the brain, to open an abscess in this situation. (Dupuytren's Lectures, published 1839. " Leçons orales," 2nd ed., vi, 183.) But in 1873 Luther Holden had already been rewarded for such hardihood by the complete recovery of the patient, whose case was fully reported in the *St. Bartholomew's Hospital Reports*, 1873, ix, 96, and the late Alphonse Elkin Cumberbatch assisted at the operation.

During this period surgery was making a leap forwards following developments in anæsthesia and results of the discoveries and teaching of Lister and Pasteur. If there were anything to urge a surgeon to trephine and open an abscess of the brain, it was the further researches of David Ferrier and the observations of Beevor and Jackson.

Further Successes by Drainage

In 1881, in Glasgow, Macewen diagnosed a temporo-sphenoidal abscess, and prolonged life though he did not cure the patient; this was the forerunner of a remarkable series of successes during the next ten years.

In 1886 A. E. Barker successfully drained an otitic temporal lobe abscess.

In 1887, in Edinburgh, Greenfield diagnosed a left temporo-sphenoidal abscess which Caird successfully drained and

In 1887, at Halle a/Saale, Schwartze had the first recorded successful operation for cerebellar abscess drained through the mastoid antrum, and von Bergmann a temporo-sphenoidal abscess.

In 1888 Horsley cured a left temporo-sphenoidal abscess.

In 1889 Macewen had his first success with a cerebellar abscess and cholesteatoma in the left mastoid.

In 1894 Ballance had his first case of successful operation for cerebellar abscess due to mastoid disease. The diagnosis was aided by the semblance of the symptoms to those produced by ablation of one cerebellar hemisphere in the monkey, with which he was familiar. After removing the diseased mastoid bone, he drained the abscess through a separate trephine opening, but came to the conclusion from subsequent experience that it was better to drain the abscess as advised by Hermann Preysing (*Zeitschr. f. Ohrenheilk.*), xxxv and xxxvii, 108 and 208) through the mastoid wound.

Since those days hundreds of successes have been published and many more important successes have been obtained. The *Proceedings of the Royal Society of Medicine* alone contain descriptions of many interesting recoveries from otitic brain abscess.

Pathology of Otitic Brain Abscess

It has long been recognized that temporo-sphenoidal abscess, like cerebellar abscess of otitic origin, is due to the infection penetrating directly through the bony wall and dura mater to the adjacent part of the brain cortex. Rarely is it possible to show that a cerebral abscess is due to a retrograde thrombus in a tributary of the lateral sinus. The tegmen of the antrum or of the tympanum may appear intact to the naked eye, or else obviously destroyed by caries, exposing the dura mater. Often, but not always, the dura mater is also discovered to be involved, either covered with granulations or in a sloughing condition, and perforated, forming part of a fistulous track between the middle-ear cavity and a brain abscess, from which pus is seen to escape. Recently Dr. Dan McKenzie wrote an interesting paper discussing the difficulties in diagnosing such forms of leaking brain abscess (*Journ. of Laryng. and Otol.*, 1933, xlviii, 797).

Though the dura mater may look healthy externally, in some cases of brain abscess more or less extensive adhesions form between it and the arachnoid, pia mater, and adjacent brain, if there is any local encephalitis. These adhesions protect the general arachnoid space from diffuse infection, though sometimes we do meet with a circumscribed abscess on the inner surface of the dura mater. It would be a fortunate circumstance if we could tell beforehand exactly where such adhesions have formed in those cases in which the dura mater looks normal externally.

When to Explore

It is sometimes necessary to explore the brain by incision through intact dura mater, to seek a presumed adjacent abscess, but it seems only justifiable to do so when the signs and symptoms are fairly manifest. For though such exploration in the absence of manifest signs may lead to the discovery and cure of an abscess in isolated instances, the practice of premature exploration yields frequent negative findings. An exploration which was negative at one stage may be followed by

manifest signs a week or two later, when an abscess is discovered by a second exploration in the same region as the first. We should feel doubtful whether the abscess then found was not the result of premature exploration. When only a day or two intervened between the operations, it is of course highly probable that the abscess was missed at first.

Cerebral Symptoms

The signs and symptoms of brain abscess are quite straightforward in some cases, while in others the diagnosis presents a problem which baffles even experienced neurologists. Headache with sickness and lethargy and loss of flesh are common to many diseases. Accompanying or following otitis media, these symptoms arouse suspicion. Optic neuritis is more often absent than present. The temperature chart often misleads, for in some of our cases there was irregular pyrexia, in others the temperature was normal, and only in few was it conspicuously subnormal, and then only for short periods which might be easily missed. Patients who were lethargic sometimes became rapidly alert, answering questions intelligently, then lapsing into an apathetic state again. If the patient appeared to be troublesome or stupid, the condition was found to be associated with some loss of memory and lack of concentration. Insomnia, restlessness, yawning, hiccup, a ravenous appetite or great thirst have been noticed, also glycosuria.

In contrast with the state of lethargy are the occurrence of general convulsions and outbreak of apparent mania, which led to discovery of signs of brain abscess. Complete hemiplegia with involvement of the lower facial muscles and hemianopia, appeared rapidly in some cases, but was present hardly at all in others. Crossed lower facial paresis alone was sometimes intermittent and transitory. Similarly crossed wrist drop, which was also periodic and recurrent and was specially noticed in the case of a large slowly developing abscess, which implicated the whole of the temporo-sphenoidal lobe.

Many interesting examples of pseudophasia (which I suggest is a more expressive term than "auditory sensory aphasia") were met with in our series, and proved valuable as signs of disturbance of symbolism represented in the left temporo-sphenoidal lobe.

Cerebellar Symptoms

In the cases of cerebellar abscess the characteristic nystagmus was not invariably found. Its absence led to fatal delay in at least one early case. It is worth recording that typical nystagmus, coarse towards the side of the abscess and fine towards the opposite side, was observed in one case one day, and the following day the asymmetry was reversed, while on the third day the characteristic form of nystagmus reappeared. In other cases in which nystagmus had been absent before the abscess was opened, it appeared afterwards when the intracranial pressure had been relieved.

Loss of muscle tone of the limbs on the same side, with incoördination, has been recognized most frequently. The useful finger-to-nose test generally revealed exaggeration of movement on the side of the lesion. Incoördination due to asynergia was observed in other purposeful movements of the limbs on the same side. Attempts to make a rapid succession of opposed movements, such as the rapid pronation and supination of the wrist, have been found even in children when they were able to give their attentive coöperation. Thus dysdiadokokinesia proved one of the most reliable signs of a lesion, but it was sometimes intermittent in cases observed from hour to hour.

Hypotonia of the limb muscles was generally detectable but was only occasionally so marked as to resemble paresis. On the other hand hypertonic conditions were rare though in one case they revealed a pronounced cataleptic feature. Ataxic gait and giddiness were seldom outstanding. These disturbances were more marked in the

early labyrinth cases than in uncomplicated cerebellar abscess. Pointing tests of Bárány proved valuable sometimes, the deviating error being towards the side of the lesion. In several cases of cerebellar abscess, as in some of cerebral abscess, the desperate state of the patient was not apparent until sudden loss of power, or of consciousness occurred, or even cessation of breathing. The latter has occurred after too rapid or excessive withdrawal of cerebrospinal fluid. When it is necessary to collect fluid for pathological tests in suspected cases of cerebellar abscess special care is taken to restrict the quantity and the rate of flow.

Character of Abscess Wall; Enucleation, Drainage

Before considering the details of surgical treatment, it is necessary to direct attention to various forms and types of abscess.

Perhaps the character of the wall of the abscess is one of its most important features. Sometimes the wall is very thick and dense, completely encapsulating a pyogenic membrane. Occasionally fibrous trabeculæ form partitions, as seen in the dense multiloculated abscess. [Specimen shown.] It is obvious that such an abscess could not be effectively drained, but should be removed complete as this was done. The dense unilocular abscess [specimen from the Museum at St. Bartholomew's Hospital shown] is also best dealt with by enucleation. The specimen was successfully removed by Mr. L. B. Rawling. Many cases of otitic abscess, however, have no adventitious fibrous walls. Brain tissue alone seems to enclose the pus, and portions of the brain are disintegrating and gangrenous, and occupy the interior of the cavity. There appears to be no possibility of enucleating such abscesses, and they must be drained. The same procedure—drainage—is necessary in dealing with the thin-walled abscesses, as well as with those abscesses which are found already leaking.

Diffuse Œdema of Brain

Another feature of brain abscess to which attention is directed, is the state of the white matter of the brain outside its walls. In fatal cases sections of the brain show the white matter swollen and œdematous. This inflammatory œdema tends to extend through the whole hemisphere, and accounts for the deflection of the normal median plane of the brain to the opposite side. The lateral ventricle on the affected side is usually occluded in these cases, though distended with cerebrospinal fluid on the normal side. Both lateral ventricles are equally distended in fatal cases of cerebellar abscess, but the white matter of the cerebellum is liable to the same kind of œdematous swelling, causing deflection of the vermis and roof of the fourth ventricle, similar to that which occurs in the cerebrum. In other fatal cases there is widespread leptomeningitis, and we sometimes find a secondary track from the abscess to the adjacent ventricle or to some other part of the cerebral cortex than that of the original path of infection.

Clinical Groups of Cerebellar Abscess

A consideration of a series of cases of cerebellar abscess shows that there are three main different sequences of events concerned in its development. To the first group belong those cases of cerebellar abscess which follow lateral sinus infection. In the second group otitis media causes labyrinthitis, before cerebellar abscess supervenes. The third group comprises those cases of cerebellar abscess due directly to otitis media, without any intermediate lateral sinus infection or labyrinthitis. The pathway of infection can be found to correspond to each group, and the precise situation of the abscess in the cerebellum also corresponds to the group to which it belongs.

Operative Procedures

When operating for brain abscess secondary to middle-ear disease, the first step has been to explore the mastoid and perform Schwartze's operation. It is unneces-

sary to perform the radical mastoid operation as a routine, and only when we know the labyrinth to be defunct or the disease in the middle ear to be very chronic, or find cholesteatoma, do we proceed immediately to remove the tympanic ossicles and posterior meatal wall.

The next stage comprises exposure of the dura mater, removing the roof and posterior wall of the mastoid operation cavity. In the case of cerebral abscess, the tegmen and the lateral wall of the middle cranial fossa are removed, working from below upwards with bone-cutting forceps. In the case of cerebellar abscess, the dura mater is exposed beyond and below the sigmoid sinus to the cerebellar fossa of the occipital bone. On the inner side of the sigmoid sinus Trautmann's area is often the pathway of infection from the antrum to the cerebellum. To attain this cranial exposure, a vertical incision of the scalp, temporal muscle and pericranium is made from the upper end of the original mastoid incision, and to expose the cerebellar fossa a horizontal incision is made in the plane of the Frankfort line (infra-orbital-supra-meatal level).

The trephine is unnecessary, for as soon as the dura mater is sufficiently exposed with a broad flat gouge the opening can be quickly enlarged, even as far as the foramen magnum if necessary, with double-lever bone-cutting forceps.

Exposing the brain: The dura mater is incised at the apparent seat of invasion whenever this can be determined, for this is more likely to lead directly into the brain abscess. Failing any definite guide, and when the diagnosis of cerebellar abscess is well founded, preference is given to an opening posterior to the sigmoid sinus, especially when this occupies a forward position.

We can easily detect a thin-walled abscess by the escape of pus when special brain-exploring forceps are introduced and opened. With the same instrument the resistance of a thick-walled abscess can be felt. The majority of abscesses we have met with could be penetrated when the instrument was sharp.

When possible I think it important to empty the abscess thoroughly in the first instance and better to use a suction apparatus than to attempt to irrigate the cavity. It is necessary to avoid force. Drainage tubes should be attached to the pericranium or dura mater, so that they remain in the same desired position even if there are subsequent swellings and œdema of the scalp.

The wound is only partly closed; when it has been possible to enucleate the abscess, it is almost completely closed by suture.

After-treatment

The most critical period is during the first five or six days following the discovery and emptying of the abscess. During this time especially, it is important to do as little as possible to the wound or tubes. Only superficial dressings should be touched. Macewen went so far as to leave the first dressing in some of his successful cases until the end of the second, or even the third, week. Perhaps we are inclined to dress our cases too frequently. Cases seem to do best when the head is kept elevated.[1]

If a case after the first five or six days is not doing well and yet does not show signs of meningitis it is probably the result of œdema of the brain. This is more frequent than retention of pus. It is therefore seldom necessary to re-explore the abscess, but an attempt to save the patient may be made by exposing a still larger area of brain, dividing the dura mater to permit herniation of the swollen œdematous mass, which sometimes relieves pressure symptoms. Many of these cases end fatally from gangrenous encephalitis, but even desperate ones sometimes recover. I propose to try the liberal direct application of magnesium sulphate in the next case affected by this complication which I may happen to encounter.

[1] As Otto Muck (Essen) emphasized.

Nothing exceptional can be claimed in the percentage of recoveries from otitic brain abscess treated on these lines. They conform with the common average between 25% and 30%. Nevertheless they include patients who were comatose, some with hemiplegia and more than one who had stopped breathing at the time of operation. Others recovered from brain abscess though also suffering from lateral sinus thrombosis, septicæmia, and proved leptomeningitis.

Illustrative Cases[1]

Chronic Suppurative Labyrinthitis. Cerebellar Abscess. Operation. Recovery.

John C., aged 28. Admitted to St. Bartholomew's Hospital, July 15, 1908.

History.— Left otorrhœa for many years.

From October 1907 to February 1908, suffered from vertigo, vomiting and frequent headache.

February 1908, was back at work until June 15, 1908, when he had headache, vomiting, and staggering gait, but not vertigo.

Condition on admission. — Temperature 98° F., soon falling to 95·8° F; pulse 72, falling to 52.

Discharge from left ear, in which patient was absolutely deaf both to air and bone conduction. Severe headache, chiefly occipital; head slightly retracted. Rombergism; standing with feet together and eyes closed he would fall toward the right. Well-marked nystagmus to left.

Kernig's sign present. Knee-jerks obtainable; plantar reflexes flexor. There appeared to be definite hypotonia of the left lower extremity. Incoördination of upper extremity. Patient was observed to yawn frequently.

Blood examination revealed a leucocytosis of 19,400 cells per c.mm.

Operation July 15, 1908.—Radical mastoid operation on left side disclosed granulation tissue and pus in a small mastoid antrum. The facial aqueduct was eroded, exposing the nerve. The erosion led into the labyrinth. The dura mater immediately posterior to the labyrinth was covered with granulations, and though well exposed transmitted no pulsations.

An incision was made through the dura mater between the sigmoid sinus and the internal auditory meatus, and into the adjacent cerebellum, to which it was adherent. About 1½ dr. of foul pus evacuated, and a rubber tube introduced into the brain abscess.

July 17: Two days later the dural opening was enlarged with the object of allowing the cerebellum to herniate in order to relieve headache, which was still severe; July 18: Frequent hiccup; July 19: Large hernia of cerebellum; July 20: Hernia now pulsating; July 23: No headache, or nystagmus; July 31: Pulsation scarcely noticeable. Leucocytes 7,800 per c.mm.

August 2: Patient is much wasted. Still complains of headache occasionally. Nystagmus sometimes present and sometimes absent. The cerebellar hernia varies in size from day to day. Pulsation returns and disappears again. Incoördination of left upper extremity, as shown by finger-to-nose test, still present; August 12: General condition improving, enabling patient to get up for the first time; August 16: Hernia of cerebellum receding, not pulsating; August 19: Plastic operation, closure of the mastoid wound.

Subsequent history.—The patient completely recovered and returned to employment. He has been seen during 1934. Still has signs of facial paresis, but is otherwise well (twenty-six years after the operation).

Cerebellar Abscess. Sudden Coma and Apnœa. Recovery after Operation during Artificial Respiration.

W. J., a farm boy, aged 17, suffering from severe headache and chronic otorrhœa. Was admitted to St. Bartholomew's Hospital, on June 20, 1922, at 2 a.m. In spite of pain he could walk and stand, and showed no discernible physical signs apart from discharge from the right ear. The house-surgeon withdrew some clear cerebrospinal fluid, obviously under pressure, and arrangements were made to operate on the ear at 2 p.m. the same day. The patient became drowsy shortly before the time for operation, and had become quite unconscious when taken to the operating theatre. Apart from confirming the evidence of middle-ear suppuration, and finding that the patient's right upper extremity remained elevated when raised (cataleptic

[1] All under author's care.

state), no other observations could be made. An anæsthetic was given, though this hardly seemed necessary, and the operation on the mastoid was begun, but before the antrum had been opened the patient had ceased to breathe. Artificial respiration was applied and the operation stopped, but breathing remained suspended while the dura mater of the middle and posterior fossa was exposed. The tension of the dura mater was much higher in the posterior fossa, and no pulsation could be felt. It was not possible, in the circumstances, to see if any path of infection could be followed up, and the dura mater was incised posteriorly to the sigmoid sinus by several radiating incisions through the dura mater covering the lateral and inferior surface of the cerebellum. The cerebellum prolapsed freely, expanding over the edges of the dura mater. In the cerebellum a large abscess was found, and on the escape of an ounce or two of pus spontaneous respiration was resumed. It was, however, necessary to apply artificial respiration again for half an hour and the patient remained comatose for about two days, then he began to recover. The results of the usual tests corresponded with the signs of a cerebellar lesion, e.g. coarse nystagmus to the side of the lesion—asynergia and incoördination in limbs on the same side as the lesion.

Patient left hospital after three months, apparently perfectly well, and he is still well twelve years since the operation on the abscess.

Otitic Cerebellar Abscess and Leptomeningitis. Recovery.

Kenneth J. G., aged 6, admitted to St. Bartholomew's Hospital, June 29, 1927, having earache and delirium. Earache had begun in the left ear five days previously; discharge three days later.

Condition on admission.—Delirious at times; had photophobia; looked ill; temperature, 103·6° F.; pulse 140; respiration 28.

Muco-pus in left ear and palpable glandular swelling over left mastoid, which was tender. Right ear normal. Head retraction, Kernig's sign doubtful. Knee-jerks and abdominal reflexes equal; plantar response flexor. No paresis or nystagmus. A tache cérébrale was present.

June 30: Mastoid cells and antrum contained pus. Schwartze's operation performed and mastoid drained with four tubes. The cerebrospinal fluid collected by lumbar puncture was turbid.

For the next five days the temperature ranged between 99° and 100° F. and the pulse between 100 and 130.

July 6: Temperature beginning to keep between 102° and 103° Lumbar puncture repeated five times during the second week.

July 13: Temperature varied at lower levels (98°-102°) pulse 100-120.

July 20: In the third week the patient began to vomit daily; temperature assumed lower level but pulse was erratic, at first 120-140, then between 80 and 100.

July 21: Coarse nystagmus to left; and definite dysdiadokokinesia of the left forearm; no papillœdema. Seen by Dr. Geoffrey Evans.

July 25: Seen by Dr. Carmichael who found the cerebellar signs more marked; double Kernig's sign suggested the possibility of infection of the cerebrospinal meninges.

The left mastoid was reopened, and more dura mater on each side of the sigmoid sinus was exposed. Although it appeared normal it was incised. No adhesions were seen, but half an ounce of pus was evacuated from the postero-inferior and inner portions of the lateral hemisphere of the cerebellum. The cavity was emptied by suction and wicks, impregnated with bipp were introduced into the cavity for twenty-four hours, to maintain contact between arachnoid and dura mater. The next day these were removed and replaced by two rubber tubes, until August 16; one week later one tube was replaced because the pulse had risen to 140 and the temperature to 103° F. This tube was finally removed on August 29.

October 12: The herniated cerebellum was receding; a plastic operation was performed to complete the closure of the wound.

The boy returned home on November 6, 1927, and now, six years later, attends school where he works and plays games just like other boys.

Chronic Suppurative Otitis Media. Labyrinthitis. Cerebellar Abscess. Operation. Recovery.

Ernest R., aged 4, admitted to St. Bartholomew's Hospital, June 27, 1927. He had been seen in the out-patient department in 1925, when he had had left otorrhœa for three months: then measles a month later, and for one month the parents had remarked that he staggered

and had noticed a squint for one week. These symptoms had disappeared after two weeks, and the parents had not again noticed anything wrong until June 1927. He had caught a cold and the left ear was found discharging three weeks before admission. He complained of pain at the back of the head, and vomited occasionally. Ataxic, falling to left; a squint had been observed. Coarse nystagmus to left; hypotonia and dysdiadokokinesia of the left upper extremity. Pointing error of left hand; no Kernig sign; all tendon and superficial reflexes normal.

This appeared to be a clear case of cerebellar abscess. The left mastoid was opened; pus and granulations were found in the antrum and adjacent cells. No ossicles were present; pus was discovered oozing from a carious labyrinth immediately adjacent to which was a track leading directly into a cerebellar abscess containing 2 dr. of evil-smelling pus. Two rubber tubes were used to drain the cerebellum. The patient's temperature for the following seven weeks was between 97° and 99°; he then developed erysipelas: this lasted for a fortnight. Finally he completely recovered and left hospital on October 4, 1927, and remains well.

Leaking Temporo-sphenoidal Abscess. Recovery.

Edwin S., aged 9, was taken ill four days after Christmas, 1916, with sudden pyrexia, diurnal remittent fever, with excursions between 97° and 105° F., for three days.

January 6, 1917: Temperature was 101° (morning) and 97° F. (afternoon). Pulse varied between 110 and 64. There had been headache and vomiting, but no optic neuritis; abdominal reflexes were natural, and there was no "tache cérébrale."

The boy then had sudden pain in the left side of the body, and the possibility of an infarct arose.

The left ear had discharged since early childhood, and the external auditory meatus was full of pus and granulations. Dr. E. Lowry consulted Dr. Langdon Brown who diagnosed cerebral abscess, due primarily to the ear. An operation was carried out the same afternoon Owing to the possibility, suggested by the hectic temperature, that the lateral sinus was infected, the left internal jugular vein was first examined and ligatured, though full of blood without visible clot. Numerous soft enlarged cervical lymphatic glands were encountered.

The left mastoid was then opened and a fistula was found leading from the roof of the external auditory meatus into the mastoid antrum (an uncommon condition). The antrum was full of pus, granulations and cholesteatomatous material, in direct contact with the dura mater of the middle fossa, the tegmen having already disappeared. Adjacent there was a track leading up into a temporo-sphenoidal abscess which was evacuated. The lateral surface of the temporal lobe was exposed by radial incisions in the dura mater to prevent herniation of the œdematous brain, but no tube was left in the abscess cavity of the brain.

After completing the radical mastoid operation the skin incision was closed and the mastoid cavity only was drained. Strange to say the boy made a complete and uneventful recovery, and is now an active young man, aged 25, and a capable motor driver.

Left Temporo-sphenoidal Abscess. Pseudophasia. Recovery.

F. U., a girl, aged 10, said to have been deaf in the left ear for two years. Had been treated for otorrhœa until nine months previously, when the discharge ceased after removal of tonsils and adenoids. No other symptoms until about a month before admission. Attended the out-patient department, complaining of pain in the left ear and some otorrhœa, but her condition was not regarded as serious until after some kind of convulsion, followed by another two days later. She was then admitted, January 8, 1922, as an emergency case. The convulsions were said to have involved the right side of the face and right upper and lower extremities.

On admission she was conscious; no hemiplegia. Temperature 101·6° F., pulse 96; tongue thickly furred; some pus and débris in left external auditory meatus; no mastoid signs, but slight tenderness on left side. The knee-jerks were unobtainable. The superficial abdominal reflexes were weakened on the right side. The child said she had no headache, and liked to be left alone. On being questioned, to test her memory for names of objects, she soon made repeated mistakes, became confused, and explained she "could not be bothered to think." It seemed probable that the child had localized encephalitis of the left temporo-sphenoidal lobe.

Operation (left mastoid) on the day of admission. The antrum and aditus contained cholesteatoma and pus, and there was an extradural abscess in the middle cranial fossa. No pulsation of the exposed dura mater could be felt. When the dura mater was incised,

it was found to be adherent to the arachnoid and pia mater on the inferior and the lateral surfaces of the temporo-sphenoidal lobe. No pus escaped through the dura mater, nor did the brain tissue protrude.

The child's general condition did not seem quite satisfactory, though neurological examinations revealed no fresh signs. She was allowed up and walked in the ward. The nurses said she seemed "peevish and irritable," and "behaved like a spoilt child," and her mother said she was "unlike her real self." In the third week she vomited unexpectedly two or three times. Pseudophasia persisted, and it seemed justifiable to diagnose an abscess in the brain. On making an incision through the adherent membranes into the left temporal lobe the abscess was at once found. This was drained with rubber tubes, and the child's condition, temperament and memory, improved forthwith.

It is twelve years since this operation, and the patient is quite well and is now married.

Recent Acute Otitis Media. Apathy. Pseudophasia. Left Temporo-sphenoidal Abscess. Hemianopia. Recovery.

R. H. G., aged 36, an engineer, caught a severe cold on July 2, 1923, followed by spontaneous otorrhœa on July 5, lasting one week, after which all symptoms disappeared. The patient kept to his bed from the outset, and was symptom-free by the second week from the commencement of the otitis media. It was then observed that he was physically and mentally inert, lacking initiative, and using incorrect words. Temperature, pulse and respirations were normal. He was carefully examined, and nothing was found to account for this curious lack of interest in himself and his affairs. There was no headache or retraction, vomiting or giddiness. All superficial and deep reflexes were normal, and muscle tone was equal in all limbs. The only clue to the abscess was pseudophasia. For instance, he called wool in the ear a "stopper"; a scent-bottle was "for scent"; the glass stopper "a bung"; a tuning fork was "a constant"; a pencil, a watch, and a knife were each called a "calculator"; the colour of the knife was "steel"; a brush was "for the household"; a comb was "the same." There was no apraxia.

July 22, 1923: *Operation.*—The left mastoid was found to be acellular, and the tympanic membrane had healed. There was no pus in the antrum, but the lining was swollen and hypervascular. The dura mater of the middle fossa was tense, did not pulsate. The temporal lobe of the brain was then explored after incision of the dura mater, and about half an ounce of pus escaped immediately. The abscess was drained with rubber tubes and iodized gauze.

July 27: The patient was interested to know where he was, and what had happened. He had complete amnesia of events in which he had been concerned during the previous four or five days. He never remembered being examined, even when he had appeared to be perfectly conscious—in fact, an example of the "dream state" described by Hughlings Jackson.

After the operation he discovered that he could not see anyone on his right side. The visual fields were examined by Sir William Lister, and it was evident that there was homonymous hemianopia, but fortunately the macula had escaped, and the patient has adapted himself to the limited fields of vision and returned to the successful practice of his profession. Furthermore, a few years later he was insured as a first-rate life by a high-class insurance company.

Acute Otitis Media with Temporo-sphenoidal Abscess of Brain on Left Side. Operation. Drainage. Recovery.

S.P.C., a man, aged 44, admitted to hospital, September 28, 1924.

History.—Patient was well until three weeks before admission when he had pain in the left ear, associated with feverish symptoms attributed to influenza. Complained of headache; vomited frequently; had had a shivering attack, and at times was thought to be delirious. For twelve days before admission a discharge from the left ear had been noticed intermittently. He repeatedly called things by the wrong name.

Condition on admission.—Semi-comatose; incoherent; yawned frequently. Temperature 97·6°, pulse 52. Tongue dry and brown.

Neurological examination (Dr. Hinds Howell).—Paresis of lower part of right side of face. Impossible to test visual fields. Also impossible to test right lower extremity, owing to ankylosis of knee-joint. Knee-jerk on left side normal. Abdominal superficial reflexes

absent. Plantar reflexes extensor on right side, flexor on left side. No paralysis or spasticity of upper or lower limbs on either side.

Ears.—Right: normal; left: very little discharge; greyish-white débris obscuring the tympanic membrane. No mastoid tenderness. After the ear had been cleaned granulations were seen on the drum membrane.

Operation (on day of admission).—Schwartze's operation and drainage through the tegmen of a left-side temporo-sphenoidal abscess.

Mastoid cells and antrum contained œdematous mucosa and pus (streptococci isolated ater).

The mastoid incision was extended upwards vertically through the scalp and temporal muscle, and the outer wall of the middle cranial fossa was removed from an area extending to about 1½ in. above the level of the tegmen antri, and including that part of the floor of the middle fossa formed by the tegmen; the dura mater looked normal.

Owing to symptoms pointing to brain abscess, the dura mater was incised immediately above the tegmen and the adherent brain explored. Pus was found within an eighth of an inch from the surface. One ounce of pus was evacuated and the abscess cavity in the brain drained with a bunch of six small rubber tubes packed into place with bipped gauze. The scalp was not sutured until a month later. The abscess was tube-drained for four weeks, the tubes being removed one by one at intervals of a few days.

The patient made an uninterrupted recovery and left hospital on November 8, 1924. He resumed his work with the Great Western Railway Company and was seen again, July 1934,[1] keeping well and still doing his work.

Chronic Suppurative Otitis Media. Lateral Sinus Thrombosis. Cerebellar Abscess. Recovery.

Sarah B., aged 12, admitted to hospital November 9, 1924, with an offensive discharge of long duration from the right ear. For three days before admission she had had earache, vomiting and giddiness. The right mastoid region was tender and œdematous. The same day Schwartze's operation was performed; an extradural abscess was found in the posterior fossa and a thrombus was removed from the sigmoid sinus. On November 14 and 15 the patient had rigors, and the internal jugular vein, which had not been touched at the previous operation, was ligatured.

November 20-23: Severe headache.

November 26: Nystagmus appeared on looking to the right. Patient ataxic; muscle of right upper and lower extremities hypotonic; test movements revealed dysmetria and dysdiadokokinesia on the same side. Plantar reflex extensor on both sides.

A cerebellar abscess containing two drams of foul pus (hæmolytic streptococci and *Bacillus proteus*) was opened and tube-drained.

February 4, 1925: Wound was closed by plastic operation; radical mastoid operation completed. All signs of cerebellar lesion disappeared.

1934: Patient is now married and well.

Abscess in Temporo-sphenoidal Lobe. Headache. Pseudophasia. Drainage. Recovery.

Lily B., aged 22. First complained of deafness and discharge from left ear in May 1926: discharge continued, and patient began to have frontal headaches, owing to repeated attacks of which she was admitted to hospital December 30, 1926. The mastoid was opened and drained. The antrum was comparatively small but was full of pus. Patient seemed much better after this but was kept under observation. Five days later, had an attack of feverishness (temperature rising from normal to 103°), and appeared to have influenza. This gradually passed off and the temperature became normal in three days.

Blood-count, 8.1.27: W.B.C. 16,400; 9.1.27: W.B.C. 16,500.

After this the pulse became abnormally slow. On two occasions it was down to 56 and 48 but most of the time was from 70 to 80.

About January 8, 1927, when the temperature was normal, patient was irritable and wanted to sit up and wash herself as the other patients did. Was annoyed with herself because she could not remember names of various articles. Did not sleep well.

On January 10 I decided to explore the brain because she called a coat button an "envelope," and "keys" she also called an "envelope," though she could read and spell and count accurately. She could distinguish coins quickly and correctly, but a medallion puzzled her.

There was no contraction of the visual fields.

[1] i.e. since this paper was read.

The same night a large collection of pus was found in the left temporo-sphenoidal lobe immediately above the mastoid antrum; the headaches were relieved, and ever since the operation—now seven years ago—the patient has been perfectly well and normal.

Chronic Suppurative Otitis Media. Fits. Pseudophasia. Temporo-sphenoidal Abscess. Drainage. Recovery.

T. C., aged 30, a printer, attended hospital 22.3.33 on account of an injury to the right pinna due to a fall. Apparently he had a sore throat and felt a little queer in the morning before going to work. He is said to have had a fainting fit when at work and was found unconscious on the floor with a slight lacerated and contused wound of the right side of the head. He had regained consciousness when seen in the casualty department. Examination of the central nervous system revealed nothing abnormal. Referred to the house physician for treatment of the sore throat and allowed to return home. Afterwards complained of headache, chiefly frontal, but a note says he "seemed queer."

April 1: Became delirious and unconscious; admitted to hospital April 2 for fuller investigation.

When roused, exhibited definite name-amnesia (sensory auditory aphasia or pseudophasia). Some cough, semi-conscious and irritable. Pupils unequal; right, medium sized, did not react to light; left small, feeble reaction. Abdominal reflexes absent, plantar response. 4.30 p.m. was roused; more irritable; both pupils reacted. 9 p.m. pupils equal and reacted well to light; still unconscious; tried to sit up.

April 5: Was drowsy; yawned often, but answered questions though not in detail. Temperature 98·2° to 97° F. Pulse 54 to 80. Respirations 15 to 20. Tongue furred and breath offensive: plantar reflexes flexor; pupils reacted; tendon reflexes brisk. Abdominal reflexes absent. Leucocyte count 9,800.

April 6: Lumbar puncture yielded clear fluid under more than 300 mm. pressure, containing 26 lymphocytes per c.mm.; chlorides were diminished; protein 60 mgm.%. sugar present; sterile.

The aural house surgeon was called in, and found pus in fundus of left meatus; he obtained a history of long-standing deafness in the left ear, with occasional earache. The last attack had begun with little discharge noticeable about two weeks before the "fainting fit" in March.

On examination.—Incoördination of movement of right hand; required aid of eyes when doing pointing tests.

No nystagmus, but some papillœdema, more marked on the left side. Name-amnesia and pseudophasia were well marked, he could not remember his name, although he recognized it when told. Wassermann reaction negative.

Dr. Geoffrey Evans considered "that immediate exploration for brain abscess was advisable," and I was therefore sent for. At 10 p.m. patient seemed to be in a natural sleep, but when roused he was very irritable and antagonistic; kept muttering "it is no good," and seemed anxious to be left in peace.

There was no localizing sign but owing to the high cerebrospinal pressure, the papillœdema, and the amnesia, and the suppurative otitis the left mastoid was immediately opened. The dura mater of the middle fossa was smooth, red and bulging, but no pulsation was observed. An abscess, close to the surface, was found, and four or five drams of foul pus were evacuated with the aid of the electro-motor suction apparatus. The interior of the brain abscess cavity was accessible to illumination and inspection, and the walls did not collapse. Two rubber tubes and bipped wick were inserted and the outer wound was packed with gauze. Pulsation of the brain became evident soon after the abscess had been opened.

Patient rapidly regained consciousness. Soon after reaching the ward he pulled off the dressings, wanted to know where he was and why, tried to get out of bed, and wished to go home "at once"—another example of the "dream state" through which he had passed.

He gradually became more reasonable but was continually using words incorrectly. One request was repeated frequently: he would call the house surgeon and say "I only want to speak to you for 'half an hour.' When do you think you will be giving me the 'lift?'"

He asked for "tweezers" to remove "a wooden" from his finger. He could not name a "key," though he explained its use. He called a spirit lamp a "mechanical light," and would often say after asking a question—"Well I leave the matter to your 'desertion,' (meaning 'discretion'").

April 25: Mr. Foster Moore found that the papillœdema had disappeared and the visual fields were normal.

After the operation there was throughout little disturbance of temperature 97° to 98° F., but the pulse was generally 90 to 100. On the fifth, sixth, seventh and ninth days it was below 70 but the average was 90 for the remaining six weeks that patient was in hospital.

At the end of one week after the operation he sat up and attempted crossword problems, but there was still some pseudophasia; this did not disappear until about three weeks after the operation.

About seven months later patient returned to work, and keeps well (September 1934).

Mr. F. C. Ormerod: In 1930 Professor Neumann addressed this Section on the subject of brain abscess.[1] He recounted his own experiences and those of many other otologists and showed that in the hands of most surgeons a recovery rate of about one-third of the cases of cerebral abscess was as much as could be expected. He recalled, however, that Sir William Macewen recorded some 80% of cures. In the case of cerebellar abscess Macewen's results were 100% of cures in four cases, to which no one else has ever approximated. Professor Neumann suggested that possibly Macewen's procedure of opening the abscess at a second operation, after exposing the dura mater and painting it with carbolic acid to obtain adhesion, might be responsible for the difference. Mr. Cairns, speaking at the same meeting, suggested that another factor might be Macewen's method of opening the mastoid bone with burrs instead of with the mallet and gouge employed by most otologists. In thinking over the cases that had come under my care up to this time I had been struck by the fact that the only two—out of seven—cases of cerebral abscesses in which the patients had recovered had been treated first by a temporal decompression by means of a trephine and drainage, and had had a radical mastoid operation performed later when the brain abscess was practically dry. Both these patients were comatose on admission.

The other five cases were all treated by a mastoid operation followed, either immediately or remotely, by drainage through the mastoid wound. In an eighth patient, in whom the temporo-sphenoidal lobe was explored by the mastoid route an abscess, lying rather more anteriorly than usual, was completely missed. I believe that this abscess might have been found by exploration through a temporal decompression. Of the five patients who died after drainage, one succumbed to rupture of the abscess into the lateral ventricle, with maniacal symptoms, one to spread of the abscess backwards, destroying the optic radiation on that side, and three to a diffuse encephalitis. None of the cases developed meningitis. Since the papers mentioned were read four years ago, I have only had one case of temporo-sphenoidal abscess, that is the case exhibited at this meeting (*see* p. 152). This patient, I believe, underwent the mastoid operation before the abscess developed, and at the subsequent operation the mallet and gouge were not used, but a very wide temporal decompression was carried out with bone forceps and the abscess was opened and drained high up on its lateral wall. I imagine that the abscess in this case began when the temperature rose, some four weeks after the original operation, and a rigor led me to perform what was, I now believe, unnecessary ligature of the jugular vein.

If one considers these nine cases of temporo-sphenoidal lobe abscess, one finds that in the three, in which the abscess was opened without operation on the mastoid process and without any hammering, the patients all recovered. Of the six patients who were subjected to mastoid operation, five died of extension of infection into the brain-substance and one of an undrained abscess. I feel that the trauma of opening what is often very hard bone with mallet and gouge is very likely to injure, by a kind of *contre-coup*, the so-called capsule of the abscess which is very friable. Decompression by trephine is not likely to injure the capsule. In addition to this, exploration is more easily carried out by a wide decompression definitely made over the lateral surface of the lobe than from the mastoid wound or any—other than a very wide—extension. Drainage through the lateral aspect is also more direct

[1] *Proceedings*, 1930, xxiii, p. 1045 (Sect. Otol. 41).

and more easily carried out than through the mastoid wound. I believe that in most cases the track from the ear is completely closed by the time the abscess gives rise to symptoms.

The danger of meningitis in either method of approach seems very slight.

The President said that the subject was fraught with so many difficulties that it would be possible to discuss them for days, and still be "in the wood."

With regard to exploration with the finger, he had had a striking lesson as to its value a number of years ago, in a case of cerebellar abscess. He explored with a Horsley's seeker but could not find pus, but with the finger he found a large abscess. The patient died and at the autopsy it was found that the seeker had passed right into and through the abscess four times. In another case he had found a second abscess when using his finger to explore the temporo-sphenoidal lobe; had he not used his finger this would have been missed. Even if pus had been found by other methods and the abscess opened, he considered it advisable to use the finger, if only to get some idea as to the size, etc., of the abscess.

The question of draining an abscess was most difficult. If a drainage-tube was used the brain closed down on it, drainage was unsatisfactory and there was great risk of pocketing of pus. Some years ago he began packing the cavity with bipp ribbon gauze, and removed a little each day, so that by the fifth or sixth day another strip had to be inserted. The first patient made an uneventful recovery, so did the second. The third did well until, when the cavity had become much smaller than it had been when the abscess was opened, he (the President) used a tube. Within twenty-four hours the temperature shot up, and the patient became very ill and died. In the next case the cavity was packed only, but a fatal result occurred. He had used packing in a number of cases with varied results, and, though he had not gone into the statistics, he thought it had proved more satisfactory than other methods of drainage.

Sir Charles Ballance said that Mr. Cairns had dealt with the treatment of brain abscess in general, a fact of immense advantage to members of the Section, because the best method of treating abscess in any part of the brain must also be the best method of treating brain abscesses of otitic origin. Incidentally all would agree with Mr. Cairns that a brain abscess was a tumour and that the ideal treatment was excision. He remembered a brain abscess which he had excised in the distant past. The wall was so thick that the abscess could be rolled about the floor as if it were a billiard ball. For such a tumour there could be no treatment but excision. Possibly some surgeons on occasion forgot that.

As to the statement that the finger was a clumsy exploring instrument for brain abscess, he (Sir Charles) would not admit that his finger was a clumsy instrument, rather he would say it was the best probe which had ever been invented. Often, with the finger he had found a brain abscess which it had been impossible to detect by any other method. Sometimes no pus could be obtained from a brain abscess by trocar and cannula, but one could always feel where the tumour was.

Much had been said about the diagnosis of these abscesses. He was extremely interested in that point. The reason for thorough and repeated neurological examinations was to ensure accurate diagnosis and no delay in treatment. Early diagnosis and early treatment were life-saving. A sign or symptom not observed was not a sign or symptom not present. He remembered several cases of abscess not only of otitic origin, but also in the frontal region, in one of which the mastoid operation had been performed and in another of which the frontal sinus had been opened. The operations had been carried out when there were definite signs of inflammation intracranially, and in the face of those signs it was of no use simply to perform a bone operation. The only intracranial inflammation which, he thought, would be resolved by a mastoid operation was meningitis serosa in cases of acute

mastoiditis in which the dura was inflamed. Even then, the mastoid operation was not enough if there were symptoms indicating meningeal trouble; treatment was not complete without lumbar puncture.

In cases of brain abscess secondary to bone disease, the disease represented one continuous disease-process; in almost all cases, therefore, one should be able to follow the disease from the temporal bone, through the meninges into the brain. If that was done and the abscess drained through the abscess stalk, the patient would be cured. Such a patient, so dealt with, would be exposed to no risk of meningitis, and there was practically no cerebral hernia. He had also performed this operation when there was an abscess in the frontal bone due to infection of the frontal sinus.

Four years ago while he (Sir Charles) was staying with him, his illustrious friend Harvey Cushing had operated in a case of brain abscess. The diagnosis between abscess and tumour in that case was somewhat doubtful. The abscess was large and was excised completely. It would not be untrue to say that the patient was well in a week; he (the speaker) saw him moving about in the ward ten days after the operation. Mr. Cairns had said that such patients ought to be kept in bed for a long time, but it was not always possible to keep them in bed when they felt quite well.

He agreed with Mr. Cairns that the surgeon himself should do the dressing in these cases. The reason why he (Sir Charles) had been successful in his first case was that he went to the hospital three times daily—morning, afternoon and evening—to look after the patient; this routine he followed for more than a fortnight, and the man recovered. When dealing with brain abscess every detail of treatment should be carried out by the surgeon himself.

Mr. E. Miles Atkinson said that both the openers had emphasized the fact that in many cases there were no definite localizing signs until late in the disease; there were only general signs—in particular headache, varying in degree and situation. It was still not sufficiently realized that this absence of localizing signs applied to cerebellar cases as much as to cerebral.

The reason for this, he (the speaker) maintained, was that cerebellar abscess was a cortical condition, starting not, as Fremel had stated, between cortex and central white matter, but actually in the white matter in the centre of a lobule, and remaining confined to that particular lobule.

The localizing signs depended largely on œdema, and if the abscess was of a chronic type, with a fairly thick wall, there was little surrounding œdema, and therefore no localizing signs. Dr. Gordon Holmes had suggested in 1922 that the localizing signs in cerebellar disease were due to involvement of the dentate nucleus.

If this was so, then the fact of the abscess being situated in the cortex far removed from the dentate nucleus and with little surrounding œdema, provided the explanation why many of them showed none of the characteristic cerebellar signs. In view of this, it was a mistake to wait before exploring until localizing signs appeared.

Another point was the transience of signs; it was, indeed, a diagnostic point. A sign "here to-day, gone to-morrow" was of great value in diagnosis.

Mr. Cairns had mentioned the difficulty with regard to "abscess in the wrong place." He (the speaker) had had a case of frontal lobe abscess which must have been metastatic from the ear, for no other infective focus could be found. There were no localizing signs; there were only headaches and the cell-count in the cerebrospinal fluid. He explored the temporo-sphenoidal lobe and the cerebellum, but failed to explore the frontal lobe in which an abscess was ultimately found.

He was sure that meddlesome surgery, such as washing out the cavity with antiseptics, etc., only served to increase the surrounding œdema, which it should be one's object to avoid.

Mr. J. A. Gibb asked whether Mr. Cairns would propose a larger opening and a free incision of the dura mater in cases of brain abscess, with the idea that if the abscess had been missed it might come towards the opening.

Mr. F. Holt Diggle asked whether Mr. Cairns had any objection to the use of a small scalpel for finding an abscess.

Mr. Cairns (in reply) said that when exploring for abscess something blunt must be used with which to appreciate resistance. If one was sure an abscess was present, a fine scalpel, used gently, would be useful for opening the abscess; Macewen used a scalpel. With regard to making a larger opening in the skull, that of course depended on what was found with the needle. If there was a deep-seated abscess, and one was not finding pus up to 4 cm. depth, it was futile to make a large opening. Deep-seated abscesses were best treated by closed drainage. If a catheter could not be got into the abscess, a stiff brain-needle should be left in situ for a few days. If there was an abscess near the surface, a larger opening could be made so that the abscess could be attacked under direct vision.

He had not had any experience of silver wire drains. Cahill, of Boston, had used them, and reported successful results from them. Neither had he (Mr. Cairns) used bougies.

With regard to dressing in these cases, when the mastoid was operated upon it might be necessary to disturb the dressings earlier, because of the discharge; for frontal sinus cases it was well to have a massive dressing.

He completely agreed with Mr. Sydney Scott's remarks about mastoid cases. Neurological surgeons did not contend that the mastoid should be disregarded, or that operation should not be done through the mastoid; often that was the right route, as it gave dependent drainage. But when there was doubt, exploration for temporal abscess should be made through a clean incision, the mastoid incision being sealed off. In some cases one was not sure about lateralization, and then both ventricles must be tapped. If both were greatly dilated, there was no supra-tentorial abscess; if one ventricle was collapsed and the other of normal size or larger, the abscess would be on the side of the collapsed ventricle.

He agreed that if the surgeon had a clear idea of what he wanted to do at operation, the battle in these cases was usually won or lost at the bedside in the stage of investigation before operation.

CASES SHOWN

Cerebellar Abscess.—MAURICE SORSBY, F.R.C.S.

George D., aged 41, was admitted to hospital, August 10, 1932, with symptoms of right acute suppurative otitis media. He gave a history of headaches and occasional giddiness for two months, but there had been an exacerbation of the symptoms during the last three days.

Operations.—A right myringotomy was performed the same day and was repeated five days later. As the patient obtained no relief from the headaches and giddiness, a mastoid operation was performed on August 17, a week after admission. Pus was found in the few cells present and granulation tissue in the antrum. The dura mater and lateral sinus were exposed and found to be healthy.

Post-operative progress.—The headaches persisted, and patient vomited for the first time on August 24—a week after the mastoid operation—when definite signs of cerebellar involvement were noticed. Temperature subnormal; nystagmus to the right: dysdiadokokinesis on right; ataxy of right arm and leg. No papillœdema.

A lumbar puncture on August 24 gave the following figures: 134 cells per c.mm.; all lymphocytes; protein 0·2%; globulin increased; sugar content normal; chlorides 700 mgm. %. No tubercle bacilli or other organisms seen. Wassermann reaction negative; X-ray examination of skull revealed nothing abnormal.

Patient's local and general condition remained unchanged except for occasional

remission or diminution of above signs and symptoms. Mastoid wound healed; pulse varying between 60-80.

Two more lumbar punctures were performed with the following results:—

August 29, 1932.—40 cells per c.mm., all lymphocytes; protein 0·15%; chlorides 750 mgm. %. All other elements as before. No organisms seen.

September 16, 1932.—12 cells per c.mm., all lymphocytes; chlorides 720 mgm. %. All other elements as before. No organisms seen.

Cerebellar exploration.—On October 10, exactly two months after admission into hospital, patient became suddenly worse, and a cerebellar exploration was undertaken and, on needling, pus was found. The abscess was opened and two drainage tubes were inserted. *Bacteriological examination of the pus.*—Streptococci present.

Post-operative progress.—The cerebellar abscess drained well; symptoms and signs rapidly cleared up. Patient was discharged feeling fit and well on November 29, 1932.

Temporo-sphenoidal Abscess.—LESLIE POWELL, M.B.

T. L., aged 11. *History.*—Ten days' cold; vomiting; pain in left ear followed by discharge next day. Pain ever since. Temperature 102° to 103°. When seen by me, January 1, 1934, was in a condition of cerebral irritability, curled up, resenting any interference, and not speaking. Temperature 103·2°; pulse 108. Apparently not hearing watch with either ear. Right tympanic membrane normal; left showed perforation, pus, and mass of granulations. Left antrum dim.

Operation same day. Lavage of left antrum producing thick mucus; ear cleared of granulations. Lumbar puncture: no increase of pressure or cells.

2.1.34: Placid; no symptoms; temperature 100·4°. No change in reflexes or paralysis; could not produce words but imitated actions and appeared to understand what was said.

Operation.—Conservative mastoidectomy (left); lateral sinus and meninges freely exposed. Meninges covered with granulations: not tense: extensive cells. Uneventful progress after this, but patient only said a few monosyllables and was apt to repeat them. Temperature normal after three days, and remained so.

14.1.34: Vomiting repeated. Discs blurred on nasal side. Hearing (right) good: speech improving; could do small sums; drew well. Right pupil slightly larger than left. Slight right facial paresis (lower).

15.1.34: Vomited again: left frontal headache. Cerebrospinal fluid clear but under pressure.

16.1.34: Operation.—Temporo-sphenoidal abscess found and drained (culture: pneumococci). Metal drainage-tube with flange—later replaced by rubber catheter end; cavity washed out daily with saline solution; steady improvement ever since; now talks almost normally; hears watch at 6 in. (left ear). Wound nearly healed and meatus almost dry. Skiagram taken after injection of lipiodol shows position of abscess; tube still in, but very little discharge from cavity.

Temporo-sphenoidal Lobe Abscess of Otitic Origin.—F. C. ORMEROD, F.R.C.S.

Edward W., aged 14. Admitted to Westminster Hospital April 14, 1933, with symptoms of left mastoiditis. There was a history of two weeks' otorrhœa and of bilateral otorrhœa in early childhood. A cortical mastoid operation was performed the same day without any unusual features being noted. Convalescence was uninterrupted until May 14 when the temperature rose to 103° and varied between 99° to 103° until May 21 when it rose to 105° and the patient had a rigor. The mastoid cavity was reopened the same day and a little extra bone removed. The sigmoid sinus appeared normal but on account of the rigor the internal jugular vein was ligatured. The temperature returned to normal in six days and the pulse only to 100. The patient was well until June 6 when he became drowsy and irritable. On June 7 and 8 the temperature fell to 97° and the pulse to 70. He complained of headache on the left side and vomited twice.

All reflexes were normal except Babinski's, which was doubtfully extensor. The ocular fundi were congested but there was no papillœdema. The cerebrospinal fluid was under increased pressure and contained thirty lymphocytes to the cubic millimetre.

On June 8 a large area of bone was removed from the temporo-parietal area by means of bone forceps, the mallet not being used at all on this occasion. A large temporo-sphenoidal lobe abscess was discovered by means of a record needle and syringe. It was opened and drained by an incision through its lateral wall. No attempt at drainage through the roof of the middle ear or mastoid antrum was made.

The abscess contained several ounces of thin, flaky pus, from which a non-hæmolytic streptococcus was grown. The abscess was drained by means of a roll of thin rubber tissue and was irrigated daily. The convalescence was uneventful from the date of the abscess being opened.

Otogenic Brain Abscess Secondary to Infection with the Streptococcus mucosus.—MICHAEL VLASTO, F.R.C.S., and I. VITENSEN, L.R.C.P., M.R.C.S.

Mrs. B., aged 45, first seen in out-patient department, October 24, 1933. Both ears discharging: the left had been discharging for three weeks, the right for five days. Severe tinnitus; no pain; both drums red and thickened. Tinnitus diminished whilst patient was under observation, but deafness increased.

November 14, 1933.—Aspiration paracentesis [I.V.]. Report on culture: *Streptococcus mucosus*, both sides.

Tinnitus and deafness continued severe, and in view of the nature of the infection, it was decided to drain both middle-ear tracts.

December 2, 1933.—Bilateral Schwartze operation. [Right M. V.; left I. V.] Both mastoid cell-systems filled with granulations. Culture from right side showed *S. mucosus*; culture on left side was sterile.

The patient had become gradually more deaf, and could not hear shouting. The deafness was of the middle-ear type. We had not previously met with such profound deafness of this type.

The wounds were granulating satisfactorily, and it was hoped that the hearing would return with the subsiding of the infective process, but the patient then took a turn for the worse. On December 23 she complained of pain over the right temporal region; she appeared to be drowsy and her pulse-rate dropped from 50 to 60. On December 28 she was examined by Dr. G. Konstam, who reported as follows:—

"Complete deafness; very drowsy; when she is roused, it is almost impossible to fix her attention, although there are occasional lucid intervals. Pupils equal and react to light. Nystagmus to the right. Fundi normal. Weakness of the lower face on the left side. Weakness and increased tonicity of left arm. Cheyne-Stokes breathing. Diagnosis: right temporo-sphenoidal abscess. Lumbar puncture: 35 cells per c.mm.; polys. 44%, lymphos. 56%."

On the same day (28.12.33) abscess located [M. V.] about 2½ cm. from the surface, rather far back in the right temporo-sphenoidal lobe. About one ounce of pus came away and drainage was secured by a single small-bore drainage tube. "The pus showed a heavy infection with *S. mucosus*. It consisted mainly of broken-down brain tissue, polymorphonuclear cells being very scanty."

The immediate recovery of the patient was dramatic. The day following the operation she wished to be on full diet and inquired when she was going home.

Present condition.—The patient has now completely recovered, and her hearing is so far restored that she can hear a loud whisper with both ears.

The case seems to us of interest for several reasons as, e.g.: (1) Many points in connexion with infection of the middle ear with the *S. mucosus*, referred to in a previous communication [I. V.]; (2) the short time (ten weeks) which elapsed between the original ear infection and the evolution of the brain abscess; (3) the intensity of the middle-ear type of deafness; (4) the dramatic, immediate and permanent recovery which ensued after the evacuation of the abscess.

We are indebted to Dr. R. R. Elworthy for all the pathological reports.

Mr. VLASTO said that the credit for first recognizing the gravity of the condition was due to his Registrar, Mr. Vitensen. Although middle-ear infection by the *Streptococcus mucosus* had been suspected from the clinical history of the case, the diagnosis was clinched after culture of the middle-ear aspirates. For that moment, past experience had taught them how seriously the case would have to be watched and that operative drainage of the middle-ear tract could not long be delayed.

The middle-ear deafness—so characteristic of *S. mucosus* infection—was peculiarly intense.

Cerebral Abscess with an Unusual Symptom.—J. ALDINGTON GIBB, M.D.

S. B., male, aged 17. Chronic otorrhœa since childhood. Recently suffered from severe headache. Admitted to hospital 24.11.29 for the mastoid operation.

On examination.—Discharge from left ear; membrana tympani almost completely destroyed; hearing good; no vertigo, nystagmus or rombergism; no dysdiadokokinesis; reflexes normal; no sensory or motor aphasia; eyes, nothing abnormal.

25.11.29: Radical mastoid operation; extensive disease; foul smell.

1.12.29: Rise of temperature; nystagmus, 1st degree; no intra-ocular changes. On looking left there was slight diplopia; this cleared up on the following day. As the temperature remained high, although there were no meningeal signs, lumbar puncture was performed: pressure +29. *Bacteriological report*: Pus cells and intracellular diplococci. Culture showed pure colony of coliform bacilli.

30.12.29: Very cheerful; marked perseveration; chuckled to himself a great deal. From this last symptom I formed the opinion that there was an abscess in the temporal lobe the contents of which had not only leaked into the cerebrospinal fluid, but had in all probability found their way towards the tip of the temporo-sphenoidal lobe and intermittently touched the frontal lobe, the pressure apparently giving the patient a pleasurable sensation.

6.1.30: Trephined one inch posterior to the external auditory meatus and half an inch above it. Exploration unsuccessful.

13.1.30: Granulations in wound bulged and pus was seen to ooze. I deliberately removed about an inch of brain covering the flow of pus. *Bacillus coli* present in pus. Examination showed a smooth-walled cavity capable of holding about two drams of fluid. The main abscess cavity followed the posterior superior angle of the petrous bone, and communicated with a new tunnel-shaped cavity which was continued almost to the tip of the temporo-sphenoidal lobe.

It is of interest that, although no eye symptoms were ever present, on firm packing of the abscess cavity there was a sensation of seeing "green stars" in the right eye. Subsequent progress was uneventful.

Mr. HERBERT TILLEY said that the Section was to be congratulated on the series of successes which these cases represented, especially since, as Dr. Neumann had pointed out in the address to which Mr. Ormerod had referred, it was extremely difficult to get a high percentage of cures in cases of brain abscess.

The case of rapid recovery after the evacuation of a cerebral abscess reminded him of the first case of brain abscess upon which he had operated. A girl, about 7 years old, was brought to the hospital in a comatose condition, and with a long history of a chronic discharge from the left ear. The symptoms suggested a temporo-sphenoidal abscess on the left side. A light anæsthetic was administered, and during its induction there occurred a profuse discharge of foul pus from the meatus. The mastoid antrum and cells were explored, their infective material was removed, the temporo-sphenoidal lobe exposed, the abscess more fully opened and a drain inserted. Next morning the patient was sitting up in bed and singing. She made a rapid recovery.

Another case he might mention was one of temporo-sphenoidal abscess. This was opened and the patient recovered. Seven months afterwards, however, he began to develop epileptic fits, the aura preceding the attacks being that of a disagreeable smell. The patient, a young man, was in University College Hospital, and he (the speaker) asked the late Sir Victor Horsley to deal with this complication.

Sir Victor opened up the wound again, found the scar of the temporo-sphenoidal abscess, and removed it. That was twenty-five years ago, and the patient has had no recurrence of the fits.

Section of Psychiatry

President—E. MAPOTHER, M.D.

[*November* 14, 1933]

Tough or Tender. A Plea for Nominalism in Psychiatry

PRESIDENT'S ADDRESS

By E. MAPOTHER, M.D.

Round, angular, soft, brittle, dry, cold, warm,
Things are their qualities; things are their form—
And these in combination, even as bees,
Not singly but combined, make up the swarm:

And when the qualities like bees on wing,
Having a moment clustered, cease to cling,
As the thing dies without its qualities,
So die the qualities without the thing.

Where is the coolness when no cool winds blow?
Where is the music when the lute lies low?
Are not the redness and the red rose one,
And the snow's whiteness one thing with the snow?

Mallock's translation of
LUCRETIUS. *De Rerum Natura.*

IT is close on a century since Charles Darwin returned from the voyage of the *Beagle* with the germ of those ideas which were destined to revolutionize not only the science of life but the whole of knowledge. Being the perfect type of inductive scientist, he was only hustled into publication about thirty years later. The particular theory concerning the origin of species which Darwin then propounded was not only incomplete, but in some measure positively erroneous. Not only did he share our persisting ignorance of the antecedents of those natural variations which form the *sine qua non* of evolution, but he lacked even such knowledge as we now possess of the differences in germinal structure which constitute the start of such variations. Further, Darwin erred positively with regard to transmission of acquired characters, and by over-estimating the rôle of natural selection.

Yet Darwin's name is rightly immortal, because he and his followers firmly established the principle that in biology, as in respect of non-living processes, the whole business of science is to account, as far as is possible, for events as a sequence in the phenomenal world, without reference to intervention of spiritual entities extrinsic to that world, and persisting unchanged throughout the sequence.

In respect of the origin of species, Darwin's attitude was not only opposed to theistic explanations, but to others framed in terms of more individual triumphs of the spirit (e.g. the wish-fulfilment view of the neck of the giraffe as suggested by Lamarck).

After a period during which theories of evolution without spiritual guidance were widely derided as blasphemous nonsense, Darwin's central principle triumphed.

From its particular application Darwin's non-interventionist principle spread to the whole of biology; it inspired all the physical sciences then, and (despite sporadic regressions towards animism) has continued to do so ever since.

It is now suggested in a centenary spirit, that in framing a science of the conduct and consciousness of man and other animals, it would not be premature to try and conform with the principle which Darwin initiated. This is particularly so, since

Darwin indicated by example his own belief that the proper data and methods for establishing a science of the behaviour of animals were analogous to those for elucidating the genesis of their form.

To put the matter more explicitly, it is suggested that the primary requisite of a scientific psychology and psychiatry is agreement that these shall not be framed in terms of animist conceptions, nor include reference to such assumptions, which properly belong to religion and in fact form the sole common features of religion.

There is no need to be deterred by the failure of previous attempts (such as Watsonian behaviourism and various reflexologies) which have been marred by extravagances such as exclusion of the phenomenal facts of consciousness and of almost all influence of the innate.

A special resistance, reminiscent of the days of Huxley, may be expected in the cases of psychology and psychiatry to this thesis of the incompatibility of science with animism. It has to be noted that the tendency towards idealism in various other sciences has been specially evident of late. Prominent exponents proclaim the belief that the inductive method is for ever incapable of giving an exhaustive account of the phenomena constituting the particular province of each science. These partisans of the spiritual insist (notwithstanding all historic evidence to the contrary) that the scientific method must inevitably leave a residue of data soluble only by resort to animist conceptions. Though in biology, in chemistry and physics particular exponents may proclaim this defeatism as their personal faith, there is no actual suggestion that these sciences as such would profit by being recast to incorporate reference to spiritual agencies. This is reserved for the so-called sciences of psychology and psychiatry. It is in these alone that one finds leading authorities laying down that accounts should deliberately be framed in terms of animist concepts as the method of choice, and thence proceeding to the doctrine that alleged success in thus summarizing phenomena (in reality a triumph of circular argument) constitutes entitlement to scientific status.

Here it may be opportune to emphasize that protest against confusion between the scientific and religious approach need not involve anything derogatory to the latter. Many scientists of course (including some of the greatest) openly profess that there are problems incapable of solution by the scientific method, but soluble in some other way, in virtue of revelation, tradition, intuition and so forth. Some hold that the private certainty of belief about such idealist concepts as God and the Soul has a more ultimate kind of validity than the public probability claimed for knowledge achieved by induction. So long as the distinction between belief and knowledge is preserved, such statements call for no protest in the name of science, which knows nothing about certainty—not even its existence. It might perhaps be agreed by all that the province of religion begins where that of science necessarily leaves off. But such an agreement does not justify *identifying* scientific knowledge with religious belief and does not alter the fact that animism involves making certain assumptions, e.g. indeterminism and purpose (using this term in a finalist sense) and that these assumptions are incompatible with the scientific method and would render it invalid.

A typically lucid statement of the position which I want to controvert may be quoted from Hart.[1]

" Freud introduced dynamic concepts while still remaining within the psychological field. He did not confine himself to those first two stages of science, the observation and classification of phenomena, which had hitherto constituted the only ground in which the psychologist was allowed to play. He advanced to a third stage, construction of causal concepts designed to explain the observed phenomena. Moreover, these concepts were built out of psychological stuff and not handed over in despair to the ministrations of the physio-

[1] My criticism of Hart betokens the facts that I think him the only English builder of psychiatry who has seriously examined its foundations and that I disagree with him diametrically as to their present state and proper nature.

logist and the chemist. This was an epoch-making step, and one which if it can be established at once raises psychology to a level with the other scientific disciplines which serve psychiatry."

Of psycho-analysis Hart says :—

"This will remain the first consistent attempt to apply to medicine a conceptual psychology along the lines which have proved so fertile in other branches of science, and have at last thrown more light upon neurotic disorder than any other method. The formulations of the psychoanalyst do enable us to interpret in psychological terms the conditions with which the psychiatrist has to deal. The psychoanalyst can claim that his method has indubitably achieved greater success than any other so far as psychoneuroses are concerned, and perhaps not had less success in the sphere of the psychoses."

With these quotations must be coupled the fact that the psychological concepts of Freud and of McDougall (whom Hart also extols) are definitely animistic.

I venture to suggest in the first place that, as regards real progress of scientific knowledge concerning psychology and psychiatry within the last generation, such optimism is entirely misplaced: in fact, that the rate of this has been deplorable.

In my view retardation has largely been due in psychiatry to distraction from painstaking factual studies of the sort which Kraepelin initiated by the facile charms of animist speculation.

Verifiable facts are only available about certified insanity; except as regards general paralysis and alcoholic psychosis there has been no reduction in incidence, in duration or in ultimate prognosis of any form of this. There has been large-scale organization of the treatment of minor mental disorders but any success achieved is mainly due to wider application of knowledge available long before Freud.

The rate of progress has been quite different in respect of the spread of information concerning real or alleged findings among the profession and the public. But such diffusion of current doctrines, opportunities for application of these in practice, and even facilities for research, have to be sharply distinguished from real movement in the frontier of knowledge. We, who after most of a generation in psychiatry, are doubtless about to die intellectually, can congratulate our successors upon the instruments which have been forged in our time for discovery. In particular, the newer institutions designed to deal with beginnings of mental disorder in childhood and in adult life, should furnish the chance to make the origin and progress of mental disorder a matter of record rather than reminiscence. But scientific results from these instruments so far are meagre.

For a variety of reasons which it would take too long to expound, animist speculations have obtained a high prestige among the lay intelligentsia—significantly greater than among professional psychologists and psychiatrists who are directly concerned with the facts which these speculations purport to explain. The situation is like that in respect of the allied movement among those professing subjective idealism in physics. In each case there is a strong tendency to suggest that acceptance is synonymous with modernity, and opposition with reaction. It is therefore relevant to note that the greatest of English physicists expressed his estimate of the respective contributions to his science made on the one hand by idealist speculation, and on the other hand by observation and experiment in the oracular utterance, "The dogs bark, and the caravan moves on."

Holt said more than ten years ago: "It has taken man ages to learn that gaps in his knowledge cannot be filled with figments of his own imagination. Psychology has not learnt this lesson."

Nominalism or Conceptualism?

Definitions.—It is the essential proposition of this address that the most fundamental choice confronting psychologists individually and collectively is that

between nominalism and conceptualism and that this choice is that between the way of science and the way of religion. In discussing this proposition, it will be necessary to employ certain terms which have been used even in philosophy with alternative and in some cases with contradictory senses. Some of the terms also have a popular usage which is quite remote from their meaning in philosophy. The following definitions are selected, with slight modifications, from those given in each case by the Oxford English Dictionary.

(1) Nominalism is a doctrine of which the more negative aspect is that universals or abstract concepts are mere names without any corresponding realities; the positive aspect (phenomenalism) of the same doctrine is that phenomena are the only objects of knowledge. (By phenomena, of course, are meant immediate processes of perception.)

In practice either term denotes a manner of thinking which considers things from the point of view of phenomena only.

(2) Conceptualism may be used as a term embracing both: (*a*) Materialism and (*b*) Idealism, i.e. as the direct opposite of nominalism and inclusive of both these alternatives.

(*a*) Materialism is the doctrine that the physical world has independent reality; that nothing exists except matter and its movements and modifications and that the phenomena of consciousness are wholly due to the operation of material agencies.

(*b*) Idealism or spiritualism is any system in which the object of external perception is held to consist (either in itself or as perceived) of ideas.

(i) Subjective idealism is the opinion that the object of external perception consists (whether in itself or as known to us) of ideas of the perceiving Mind.

(ii) Absolute idealism is the opinion that it consists not only as known to us, but in itself of ideas—not however ours, but those of a universal Mind. Thus absolute idealism corresponds to panpsychism.

The really living form of this conflict in psychology and psychiatry—and indeed, in science generally—is that between nominalism and the idealist variety of conceptualism. Materialism as defined above is defunct—if indeed it ever existed, except as a mythical butt. It is more than doubtful that it was ever seriously held by the leading scientists of any time—although attempts to father such views upon their opponents are common among idealists.

The issue between nominalism and idealism is both ancient and modern. Its persistence throughout history would seem to correspond to the existence (in respect of cognition) of a pair of contrasting trends in human personality.

Jung equates inclination towards nominalism or towards conceptualism respectively with the cognitive aspect of extraversion and introversion.

In the main the disposition to nominalism or conceptualism corresponds to "Tough-mindedness" or "Tender-mindedness" as distinguished by James. But Jung classifies as essential certain of the contrasting pairs of characters ascribed by James to his two groups and as non-essential certain of the others.

The following table represents, with some slight rearrangement (mainly suggested by Jung) the antithesis originally suggested by James:—

Tough-Minded (*Related to extraversion*)	*Suggested corrections*	Tender-Minded (*Related to introversion*)	*Suggested corrections*
(*a*) *More essential*:—			
(1) Materialist.	Nominalist.	(1) Idealist.	Conceptualist.
(2) Sensationalist.		(2) Intellectualist.	
(3) Fatalist.	Causalist.	(3) Free Willist.	Finalist.
(4) Pluralist.		(4) Monist.	
(*b*) *Less essential*:—			
(5) Irreligious.		(5) Religious.	
(6) Sceptic.		(6) Dogmatist.	
(7) Pessimist.		(7) Optimist.	

COMMENTARY ON TABLE.

(1) *More essential characteristics.*—It may have been true in the day of William James to say, as he did, that the tough-minded was a materialist. Now that it is common knowledge that matter and all its sub-divisions—molecules, atoms, electrons—are conceptual fictions, it would be more true to say that the tough-minded is a nominalist. This will make no difference to the idealist's view of him as a heathen in his blindness bowing down to wood and stone. But if the nominalist is now free from doubt about the conceptual nature of Matter, he is at least as clear concerning the hypothetical nature of any unity dubbed Mind. For the nominalist the thoughts themselves are the thinker, pending any proven usefulness of the opposite view as an instrument for the discovery of unknown phenomena. The distinctive feature of nominalism is retention of awareness that words are just symbols, designed to express observed sequences of phenomena (whether subjective or objective). To the strict nominalist a "thing" is merely a term for a recurrent pattern of concurrent sense impressions. Abstract nouns are terms for the very fact of recurrence of such concurrent patterns. For the nominalist, all symbols—gestures, words, figures alike—are tokens easing exchange; they are merely alternatives to more concrete forms of barter, such as pictures. For the nominalist the coinage of words, which admittedly are inconvertible for ever into terms of phenomena, is merely debasing the currency of thought. To him the conceptualist's practice of accounting for the unknown in terms of the unimaginable is just verbiage—a children's game with valueless counters.

For the conceptualist, words, especially those denoting universals of any kind, tend to have a totally different significance. The classic example of conceptualism is the statement attributing to a soporific principle the fact that opium produces sleep. To the conceptualist it seems satisfactory to "explain" phenomena by the invention of *ad hoc* entities and "forces" subsisting somewhere that is nowhere and endowed with exactly the capacities required to account for the phenomena already observed. Taking words that should be regarded as merely collective terms for classes or sequences of phenomena, devoid of any perceptible relation in space-time, the conceptualist reifies these words as if they stood for "things" in the sense in which a nominalist would use that term.

So far we have considered only a neutral form of conceptualism from which might be derived either materialism, idealism or dualism (i.e. a combination of these two realisms). A distinctive change occurs when the idealist breathes into the symbols which he has created the breath of life and attributes phenomena to their free-will as first cause. By the idealist, collective terms tend to be not merely reified, but animated. Those denoting activities are treated as if agencies, as if not merely living, but as if persons. Thus from the reifications of abstractions, which is the primary and common form of conceptualism, there follow as idealist derivatives animation, personification, and the development of deities by projection. Eventually the idealist claims that the very lack of correspondence of his verbal concepts with anything perceptible, their timeless quality and absence of spatial relations, give them a superior kind of "reality." It is hard to discover what exactly the term "reality" here implies beyond approbation. However, to many it seems as senseless to question the reference of the phenomena of human behaviour to the mind or soul as to our ancestors did doubts about demonology and witchcraft. Actually such reference is a sample of the same animism as was described by Tylor in "Primitive Culture," that by which the savage accounts for every process in the universe which he does not understand—thunder, the wind, and the flow of the river, as well as activities constituting life—by ascribing it to a spirit exercising the free will which he imagines himself to possess.

(2) The nominalist in science is interested in the study of phenomena; to him point by point correspondence with prior experience and the capacity to lead on to

novelties in experience are the crucial tests of value. The idealist is interested in formulations and patterns *per se*. The typical idealist is the pure mathematician totally indifferent as to that for which his symbols stand.

(3) To the nominalist, the determining quality of conscious purpose and free will, the influence of that which is extrinsic to the phenomena and of that which is to come, seem as completely illusory as the once self-evident beliefs in the geocentric universe and the creation of all in the heavens and on earth for man's temporal pleasure and eternal profit.

(4) Nominalism emphasizes induction from particular instances to general rules; idealism favours deduction from the general to the particular. Idealism tends to proclaim the empire of one principle, nominalism towards the slow federation of independently established formulæ.

Less essential characteristics.

If we consider the attributes of the Tough and Tender as tabulated, we find that the tough or nominalist type is alleged to be irreligious, sceptical and pessimistic. Commonly, though not constantly, these adjectives apply in a limited sense. To the idealist with his zest for circular argument it seems adequate to explain all human behaviour and consciousness by ascribing them to a Soul, or Entelechy, or Mind, according to the vogue at the moment of religion. In the same way, all problems of the cosmos can be solved by invoking deities and their ways. If the time is more scientific this ultimate personification can always be termed the Universal Spirit, or Nature, or the Life Force.

The nominalist has no such ready resources: he is too crude for the subtleties which distinguish one of these explanations as a part of science, and the rest as religion. He sees all religions as the idealist sees all but one. Even if he holds a belief in the existence of subjective purpose and control of the cosmos, the strict nominalist will probably doubt the capacity of man to imagine the nature of either. He may even doubt whether if they exist they are inspired by ethical values obviously derived from the expediencies of a reproductive and gregarious animal. But a reasonable nominalist would, of course, no more deny to a scientific colleague the right to hold, when not on duty in his own field, any of the numerous varieties of animism, than the right to belong to one of the equally numerous sections of Liberal or Labour Parties. On the contrary, he may well think that these private orgies of certainty are a good thing in the bleak life of a scientist.

The nominalist is said to be sceptical and pessimistic. If these adjectives mean that he is apt to rate less high the achievements of the present and the prospect of a personal future, perhaps this is true. So far as biological usefulness is concerned, this seems not to matter. Most of us have heard of the wasp that (heedless alike of subjective purpose and vegetarian scruples) stings in every segment and so paralyses the caterpillar, thus making it a living larder for the grubs no mother wasp has ever seen.

Here anticipating criticism, it is necessary to say that one is perfectly aware of the paradox that consistent nominalism is itself a conceptualist fiction, that the nominalist is a personification, not a person; in fact one might say that the strict nominalist does not exist, but he knows it.

However, there is no doubt whatever that nominalism, steering between the assumptions of idealism on the one hand and those of materialism on the other, is the essence of science. Mere number and even repute of adherents of a scientific theory is immaterial in comparison with more impersonal criteria. We must beware of the appeal to authority, against which modern science was a revolt.

Apart from the conscious reservation of certain themes as the sphere of influence of religion, many scientists unconsciously substitute belief for knowledge. All scientific education commonly fails quite to eradicate the conceptualism ingrained

since childhood in thought and almost unavoidable in language; this tends to crop out as a belief either in the superior reality of a hypothetical subsisting entity termed "Matter," or as a conviction of the sole ultimate reality of another universal termed "Mind." So long as it is recognized that such beliefs are matters of personal feeling having no claim to general validity, no harm is done.

It is rather common nowadays to mock at the *naïveté* of those physicists whose writing seems to indicate materialist beliefs in the reality of atoms, electrons, forces, quanta, and so forth. Despite carelessness of expression the great majority of physicists for a generation (since Mach and Pearson) have been alive to the nature of these concepts.

Anyhow, charges of *naïveté* would be out of place unless equally extended to all idealists (e.g. Freud), who regarded spiritual entities—Mind and all its subdivisions —as objective realities.

If, like Jung, we largely equate predominant extraversion with nominalism, predominant introversion with idealism, and if we believe that such dominant tendency of the individual to introversion or to extraversion is of very early origin if not innate, then we should see that what constitutes private truth for every individual is a subjective problem depending on the standard with which each seeks conformity.

If it were agreed that the varying receptivity shown by individuals to the Freudian among other idealistic psychologies is rooted in something as old and fundamental as the controversy between nominalism and idealism, then in much of current controversy each party might possibly be less offensive to the other. We might be less disposed to think that the only possible explanations were amentia, dementia, or moral anomalies. We might be less prone to think that any purpose is served by bandying backchat about sexual perversities. If we recognize that the conflict is one that has gone on for thousands of years as to what constitutes reality and truth, then we might even agree to differ about an insoluble problem.

The exponents of psycho-analysis might be less sure that resistance is rooted in pre-senile conservatism of its opponents; they might be less confident that a little salutary superannuation will shortly ensure the triumph of their truth. The opponents of psycho-analysis might at least show the tolerance which is customary towards the religion of others, though this would not involve acceptance of claims stated in terms that are contrary to definition—such as that psycho-analysis is science.

The Nature of Science

Hart's discussion of the philosophy of psychiatry has made most of us familiar with the preliminary question as to nature of a science. Science is distinguished by its subject matter, which is sequence of phenomena, and specially by its aims and methods. George Henry Lewis perhaps stated the matter most tersely when he said: "Science aims at the power of pre-vision based upon quantitative knowledge."

Stated more fully, the goal of science is the production of formulæ summarizing the maximum number of past phenomena in the simplest, most concise and most frugal manner possible, and enabling us to foretell the sequence of future phenomena with the maximum economy of thought.

It must be emphasized that the satisfactions which science seeks are intellectual ones, and particularly the power of forecast. It is no necessary part of science to give practical control, and the power to do this has no direct bearing on scientific truth. Otherwise every foolish dogma, whether political or religious, used to produce unity in the body politic, would be true so far as effective; each of the current devices for making a desert in the province of thought and calling it peace, would be equally scientific. This should be borne in mind in considering whether the claims of psycho-analytic theory as science are much strengthened by any effect its

application may have in harmonizing the lives of neurotics. Questions involving the validity of nominalism or of conceptualism—the most crucial problem of knowledge—cannot be settled by assertions about the power to do this, especially when the degree and attributability of the alleged improvement cannot be verified owing to the privacy of the application.

Even evidence of discovery incidental to work on a given theory is not enough to prove it science. Proof must be forthcoming that there is inseparable connexion between the theory and such phenomenal knowledge as has been created by its exponents. Astrology and alchemy, the quest of the philosopher's stone, of the elixir of youth, and of perpetual motion, all led to real discoveries incidental to work based on totally false hypotheses. It is essential to remember that the sole criterion of whether a theory is scientific consists in the extent to which, on examination, it is found to conform to the recognized requirements in respect of observation and interpretation.

It has been emphasized by Hart that the logical (if not necessarily the historic) course of a science consists of three stages: (1) Observation of phenomena, i.e. of sensory data; (2) classification of these; (3) the induction of conceptual formulæ to summarize them.

As regards methods of observation, there are three primary demands of science, failure to satisfy which nullifies the eligibility of any material proposed for interpretation. First, the methods of observation must be public methods. Secondly, these methods must permit of discrimination how far any observation is truly impersonal. Thirdly, no scientific method can be held to have any promise unless it lends itself ultimately to quantitative results. This is closely related to the determinist character of science.

I venture to suggest doubt concerning the tenability of a distinction between classification and conceptual formulation of sequences. All categories and heads of classification are conceptual, though their nature as such is often ignored by their creators. The distinction between classification and formulation is often nil; moreover, both are apt to be followed by the same processes of reification, animation and personification.

The crucial discrimination is really that between observation and interpretation. This is the same as distinction between news and views, taught to every reporter and ignored by every editor.

Verifiability is essential to the value of hypotheses. In science there is need to be cautious with those who claim many and fundamental advances. It should be remembered that mere novelty is no great claim, as the files of any patent office would show.

Charles Darwin said: "I have steadily endeavoured to keep my mind free so as to give up any hypothesis however much beloved (and I cannot resist forming one on every subject) as soon as the facts are shown to be opposed to it."

If psychiatry is to progress, it is necessary that free speculation should be encouraged, but also that the conditions of such encouragement be those which Darwin indicated and observed. It is desirable that an investigator should constantly be seeking a formula which will cover even two phenomena. But it is essential that such a formula shall be kept to oneself until tested, not proclaimed as truth. The only mode of trial is the search by deductive reasoning for a third phenomenon which must logically have certain characters if the formulation be correct. Until such check has been applied, and quantitative coincidence of experience with expectation is publicly demonstrable a formula is without proof or value; if permanently incapable of such tests, it is useless. It was submission to such crucial objective tests that established the theory of relativity and that broke the phlogiston theory.

Regarding interpretation in general, one need only mention again the necessity of

simplicity, conciseness, and comprehensiveness as requirements of any scientific theory. Comprehensiveness covers not merely self-consistence, but also consistence with all known observations in the same field of knowledge and continuity with the rest of science.

Now as to economy of hypothesis. I think it is this requirement which is utterly destructive of the idealist theories which have recently dominated psychiatry. It is true that in construction of scientific formulæ, subject to explicit announcement of the liberty one is taking, one is free to make such assumptions or hypotheses as are indispensable. But the scientific quality of a formula is not enhanced by its content of assumption. On the contrary this quality is exactly in proportion to the reduction of assumption to a minimum. That is the principle of William Occam's razor.

As shown in the first quotation given above, Hart, in a typically idealist manner, makes of introducing conceptual fictions into formulæ summarizing the sequence of phenomena a positive merit, in fact a *sine qua non* of scientific psychology.

It really cannot be maintained that "construction of causal concepts built out of psychological stuff" is the *sine qua non* of a scientific psychology. Spearman's work consists essentially in the discovery of methods for measuring quantitatively certain intellectual phenomena, and assessing the individual efficiency in respect of these. Everyone would agree that Spearman's work is psychology, and that exact quantitative study of this sort is typically scientific. Yet it should be noted that Spearman gives three theories of the nature of "g," of "s" and of other factors, every one of which refers them to a property of the brain not of any extraphysical mind.

Hart appears to underrate the utter objectivity of real modern science. Its ultimate aim is neither materialist nor idealist. Modern physics as viewed by experimentalists is essentially concerned with *events* and with their sequence in space time. It is completely agnostic as to objective existence of entities which endure between those events. Almost any modern physicist would admit that the electron is essentially a symbol for the location of certain phenomenal events in space time, and may be no more.

Psychology should be as lucidly sceptical. Its pride should be not in the introduction of conceptual entities of a subsisting kind, but in reduction of reference to them. If for the sake of brevity one were to distinguish between things, thoughts and thinkers, then one might say that a scientific psychology should be clear about thoughts as being the sole object of direct knowledge, and be utterly agnostic as to the very existence of either things or thinkers. It might find the postulation of either of the latter a convenient symbol, but should be on its guard about confusion between usefulness as a symbol and existence as phenomenon.

Here we must distinguish between hypotheses of two kinds. Those on the one hand postulating entities and processes which are potential objects of direct sense perception (although for such reasons as imperfection of methods and instruments they have not yet become so) and those on the other hand postulating entities and processes which admittedly could never become perceptible.

Postulation of the first or verifiable type, in response to the challenge offered by apparent discrepancies and irregularities, has led to some of the greatest discoveries. Here belong the forecast of unseen planets, of the elements missing from the periodic table, of the elements which mixed with atmospheric nitrogen made its properties differ quantitatively from those of pure nitrogen as derived from compounds. To-day a similar challenge is presented, to which I shall refer later, namely, that involved in the principle of indeterminacy. To this the idealists wish to respond by extending the concept of free will to the physical universe.

As to the second type of postulation, the attempts to account for the unknown in terms of the unimaginable, to explain the sequence of phenomena by the intervention

of verbal entities having no such conceivable relation to space time as could ever render them objects of direct perception, surely this is out of fashion in science.

Of course modern science is a scheme for representation by static symbols of the sequence of phenomena which form its subject matter. Even the translation of music into notation is representation of the sequence of phenomena transient in time by a subsisting set of spatial symbols. In the same way, in psychology, if it were freely admitted that description of the Mind or the Soul and of its parts was only a spatial diagram representing the temporal sequence of mental processes of several varieties, then these terms would be less objectionable. If used as the name of anything which abides, then one might as well talk of bits of the wind.

Further, science has always been pluralistic and addicted to explanation in terms of a multitude of minimals. It has finished with Matter and Ether, and with grandiose generalities of that kind. At a time when physics has lately discarded the materialist view of Matter and Ether, it hardly seems appropriate to term psychology scientific in virtue of the idealist embodiment in its theory of the Conscious and Unconscious Mind, the Id and Ego and Superego. Formerly, Hart repeatedly emphasized an analogy between assumption of the Unconscious Mind, and the weightless fictionless Ether—their equality as concepts. This equality for scientific purposes may be conceded; they will soon be merged in the equality of death, though doubtless they will survive in popular language.

It might be said that postulation of minor subsisting entities of a psychological order, e.g. ideas, complexes, instincts, was comparable to assumption of electrons, atoms and molecules. Possibly this is true, but if so, psychology must be as clear as is physics about the wholly symbolic quality of all these alleged entities persisting between phenomenal processes which alone can be directly known. Thus we get back forty years to agree with William James, that an idea persisting between its successive appearances in consciousness is as mythical an entity as the Jack of Spades.

There is not the least doubt that members of the idealist schools in psychology are wholly blind to this view and regard their various anthropomorphs as being at least as objective as postulates of the verifiable type.

As for matter, so for energy, as for the electron so for the quantum. The general concept of physical energy is not to be regarded as anything which persists or compels, but as a convenient measure of equivalence in the sequence of physical events of various kinds. In the same way, terms like life force, élan vital, horme, libido, *et hoc genus omne*, could have no justification except as analogous measures of the equivalence of events in the mental series.

I have always had difficulty in understanding the glow which some psychopathologists of our time get from the blessed word dynamic. By a queer twist the word dynamic is used in psychology for those varieties of explanation which consist in referring events to static entities, and to the power of these to exercise compulsive forces.

Of such subsisting entities, the most widely popular are the conceptual instincts. Hart says that the various instincts can be regarded as driving forces, that this enables us to conceive the sequence of thought and behaviour in man as a result of the interplay of various instinctive forces and thus provides a dynamic standpoint, lifting psychology above the level of a mere descriptive science. Thus it is no longer limited to recording the how of phenomena but can attempt an answer to the question "Why."

To the nominalist the question "Why" in a sense different from "How" is unanswerable, and the idealist answer seems verbiage.

The first thing about which to be perfectly clear is that conceptual "instincts" as opposed to "instinctive processes" are merely heads of classification. McDougall's own well-known definition relates instincts to "objects of a certain

class." What makes up a "class" depends on the caprice of the observer. If the unity of the "class" were based on anything objective, e.g. on any such fact as that an instinct consisted of a given set of reactions which varied jointly in heredity or that the set was jointly activated by administration of some gland extract, or that it was abolished as a set by any known lesion whether morbid or experimental, then in such case there would be objective evidence for regarding the "Instinct" so called as a unity. There is no such evidence in the case of McDougall's, Freud's or any other known list, and anyone has equal rights to make another list.

In 1918 I was billeted in a kitchen with a brick-tiled floor. I had a kitten which had been separated from its mother as soon as its eyes were open. There was snow outside, and the kitten could not go out. In fullness of time it developed a practice of scrabbling at the brick floor with its front paws, turning round and defæcating and then scrabbling again in a typically feline and perfectly futile attempt to cover up its fæces. This homely instance illustrates just what one means.

We have here beyond question a pretty example of an instinctive process: but of what instinct in the grand sense is it a manifestation? You can take your choice.

(1) You can assemble this behaviour with the practices which all cats have of washing their faces with their front paws, scratching their ears with their hind feet, and licking their kittens, and so construct a sanitary or toilet instinct.

(2) You can emphasize that the cat is a solitary hunting animal with no use for publicity, while the dog on the other hand is an animal hunting in packs. It is possible that the behaviour of a cat in defæcating stealthily and that of the dog urinating against every upright object, are features of their different hunting instincts.

(3) To the psycho-analyst, presumably, their behaviour would be manifestations of anal erotism and urethral erotism respectively, and analogous to the burial of treasure and the display of it. We should be invited to regard the rest of the differences in the character of the cat and dog as consequent.

> "There are five and forty ways of constructing tribal lays,
> And every single one of them is right."

It is difficult to understand how Hart can regard as an addition to science the idea of Instinctive or any other Forces driving anything. His Philosophy of Psychiatry was largely based on Karl Pearson's Grammar of Science. Karl Pearson dismisses the notion of force as a cause of motion; as he says, the idea of forces as compulsive entities is one borrowed from animist theories of human activity. The notion arises as a projection of a sense impression in ourselves and how this subjective phenomenon can cause motion in the physical world would puzzle even a metaphysician to suggest. Force is not a cause but a measure of motion; it is merely a description of the routine of experience.

Coupling these lines of argument, one may reasonably ask whether reference of behaviour to the "driving of Instinctive Forces" is really likely to serve as an instrument of discovery.

The next points to be considered are the essential character in science of determinism in the sense of causality, and the sense in which the conception of purpose is reconcilable with science. Unless there be order in the sequence of phenomena, there cannot be the foreknowledge of the future which is the goal of science. This applies as much to psychology as to physical science. Determinism and causality are the essence of science, as indeterminism and free will (i.e. the influence of extrinsic universals upon phenomena) are the *sine qua non* of religion. To the extent that such influence is credited, science is impossible. Therefore, science must exclude reference, not only in particular instances but in general principle, to the intervention of free will and such first causes.

It is necessary, however, to be clear as to the limited meaning of causality in science. Causality is merely an affirmation of the probability that given antecedents

will be followed by the same consequences as have hitherto occurred in the routine of experience. Science as a method is a quest of probabilities; as a body of doctrine it is a statement of probabilities. Probability is proportional to the frequency with which a sequence has already been publicly observed. But this implies excluding the intervention of first causes. If the possibility of these were admitted calculation of probabilities would be stultified.

The essential method of science is induction. Inductive knowledge can never attain certainty: only belief can do this. Inevitability or the existence of some extrinsic compulsion is no part of scientific determinism. There is a well-known metaphysical limerick.

> There was a young man who said "Damn!
> It grieves me to think that I am
> A body that moves
> In determinate groves,
> In fact not a bus but a tram."

This is contrary to scientific determinism, since tram-lines stretch fore as well as aft.

The so-called psychological determinism of Freud, affirming the entire independence of a mental series of phenomena from all others, is not determinism in the scientific sense, but the extreme negation of this.

I wish now to turn to the questions of how far the concept of purpose is compatible with science in general, and particularly how far the concept of purpose can be reconciled with a scientific (i.e. determinist) psychology. Difficulty as usual arises from the employment of a nebulous word in many senses, and most of this would disappear if the word "purpose" were replaced by a number of terms each with an exact meaning. The word may mean firstly objective purpose, i.e. adaptation obvious to an observer, or secondly subjective purpose, i.e. the consciousness of this by the subject. Confusion is created by flitting from the one sense to the other and ignoring their independence.

Objective purpose or better, adaptation, is a universal character of life. It is clearly inherent in vegetable as in animal organization, it is as evident in persistent structure as in reactions.

With many closely adapted animal responses at low level, there is no evidence even suggesting association of consciousness. It is axiomatic about instinctive processes that consciousness of the end to which objectively they seem directed is not indispensable. There therefore seems no justification when analogous adaptation occurs at a higher level, for asserting that of this adaptation the subjective consciousness is a necessary prerequisite. The subjective consciousness of purpose is, of course, a correlate of the adapted action, but the unsolved problem of their correspondence is that of the mind-body relation generally.

The compatibility of "purpose" with science seems to turn on whether the implication is that events depend wholly on the past, or in part on the future, in fact whether by purpose one implies a causalistic or finalistic view. Recognition of causalistic adaptation, e.g. of adapted structure reached *in the species* in virtue of survival value, or of adapted reaction patterns brought about *in the individual* by success and pleasure and reinforced by habit, is perfectly compatible with science; so is any other so-called purpose that can be explained as having its roots in the past. It is finalism that is incompatible with science. Such finalism is openly professed by McDougall, Jung, and Adler; it is really implied in the Psychology of Freud, though this may be denied.

Of scientists of all kinds it may be noted that if they believe in a failure of determinism, and in the occurrence of intervention, it is generally in provinces outside the one within which they have devoted themselves to the establishment of order. If in their own field it is only in a vague and negative way as a substitute for confession of ignorance. No worker in natural science really proposes to solve

its problems by introduction of subjective or supernatural concepts, or thinks himself liable to reconcile objective findings with revealed accounts.

There is a curious tendency among workers in physical science to take for granted that airy flights into conceptualism which they would not tolerate themselves, are indispensable features of psychology, e.g. to accept the whole Freudian hierarchy as discoveries not inventions. It is particularly common to assume that determinism in psychology is impossible. If it were so, a scientific psychology would be impossible; but this defeatism seems premature.

Recent Prevalence of Animist Psychologies in England

A trinity of doctrines has predominated in England during the past generation, those of McDougall, those of the psycho-analytic school (especially Freud) and Hart's apologia for the first two. It is worth considering what constitutes unity of this trinity, what its general influence has been, and, very briefly, what are the distinctive features of each person of it.

Resemblances and differences exist in three respects:—

(1) In choice of subject matter.

(2) In relative prominence of interpretation in proportion to strictly objective observation.

(3) In metaphysical standpoint.

(1) *Subject matter.*—Of each of the above psychologies it may be be said that its subject matter consists almost exclusively of subjective processes, i.e. changes in consciousness and the alleged activities of hypothetical entities of a non-physical kind, termed "Instincts," the Unconscious Mind *et alia*. Despite differences, the aim of all is thus to give a self-contained account of the sequence of subjective processes. For none is *behaviour*, i.e. the objective aspect of psychology, of comparable interest; this may be affirmed despite references in definitions of psychology by McDougall and by Hart to *behaviour* which are not borne out by the rest of their writings.

(2) *Relative paucity of observation and prominence of interpretation.*—Of McDougall and Hart it may be said that they hardly purport to be concerned with the making of original observations. Their work consists almost entirely of interpretation, i.e. of classification and conceptual formulation of previously known phenomena.

No doubt it takes all sorts to make a world of psychologists, but the influence upon the weaker brethren of this wealth of interpretation with such scarcity of observation is surely unfortunate. It seems to foster in them a misconception of the duty of a psychologist, an under-valuation of factual data and a tendency to contentment with speculation and with translation of platitudes into jargon.

It is not true in the same obvious way of the psycho-analytic school that their contribution lacks record of observational data; but here the question arises how far the method of observation is invalidated by the intrusion of pre-conceptions. Here it may be said that almost the whole emphasis is on selective retrospection and that this tends to be guided by the principle that nothing is too banal to be momentous, if only it is sufficiently remote.

(3) *Metaphysical standpoint.*—All the persons of this trinity are idealists, though each of a different variety. All profess animism; for all alike the first business of psychology is to save its soul.

McDougall upholds psycho-physical interactionism. He is clearly aware of the difficulties of this position and his defence of the case for the soul is apt to remind one of the apology of the housemaid for her love child on the ground that it was such a little one.

Psycho-analysis is clearly based on psycho-physical parallelism; this is explicitly confirmed by Flugel. He makes no reference to the difficulties of this form of

dualism which, except by psycho-analysts, has been almost universally abandoned. This theory of the coincidence without contact of the physical and conscious series implies a continuous and meaningless miracle, unless the two are unified (as by Descartes) through reference to a universal spirit or deity.

Hart started, like Freud, with psycho-physical parallelism; later he abandoned this, probably for the reason above given. His attitude towards Freud implies some form of animism. In his Presidential Address Hart seemed to display a leaning towards the subjective idealism professed by Eddington and Jeans.

In his "Philosophy of Psychiatry" Hart said: "Historically the physiological conception of insanity arose as a reaction against the theological and metaphysical explanations of the middle ages." In view of this it is fair to draw attention to the theological implications of all animism. Freud and Hart avoid discussion of these. But one cannot thus tactfully play the metaphysical ostrich. The phenomenalist who admits that any relation of conscious and physical events, except an empirical one, is an unsolved mystery can leave the matter there, but the animist cannot decline to follow to their logical conclusions the assumptions which he has imported into science. McDougall affirms that panpsychism is the inevitable corollary of all forms of animism but his own. I believe that competent philosophers would agree with his rule, but not with his exception. The question will be dealt with again later. The matter is of the utmost practical importance. Without some such unifying intervention, mental heredity would be totally incompatible with any one of the three metaphysics of this trinity.

Freud

It is impossible to make more than a brief mention of certain general characters of Freud's teaching which are relevant to my theme. This necessary limitation may suggest a wholly critical attitude; this would be misleading. Of the brilliance of Freud's intellect there is no question. I suggest, however, that his thought is that of the artist, not the psychiatrist. His theories are full of that eclectic emphasis which is the very essence of art, and remote from the dispassionate evaluation of all facts alike which is the ideal of science. Indeed one may suggest that Freud has brought to science the mind of a poet with the defects of its qualities. To a more romantic age, before progress had taught us that art has little to do with beauty, the term poet might have seemed an odd one to apply to the author of the theories of anal erotism and penis envy. But of Freud at least it is true that his study is that of emotion recollected in tranquillity, and to him seem to apply Mathew Arnold's words—"The poet sees not deep but wide." Freud, in fact, displays an amazing fertility in picturesque and arresting generalization, coupled with no comparable gift for seeing objections, limitations or exceptions.

I propose here only to indicate why the methods of observation which Freud has devised seem unfitted to provide evidence that is valid for science.

(1) Psycho-analysis is fatally handicapped by its privacy; one cannot be detective, advocate, jury and judge in the same case—the case of the scientific adequacy of psycho-analysis. The history of miracles and witchcraft has finally settled the status in science of any mass of alleged fact that cannot be submitted to verification by the sceptical. The size of this mass and the number of believers does not matter; mythologies, especially if brightened by pornography, have never throughout history lacked worshippers, and unless human nature radically changes, they never will.

One sees Freud compared to Galileo. Would-be Galileos should remember that he created modern science by asserting the priority as evidence of verifiable observation (capable of being publicly repeated and analysed by experiment) over tradition, speculation and authority.

(2) Critics have always contended that the observational methods of psycho-analysis warped its findings. No patient is ever free from knowledge of what is expected: however painstakingly an analyst abstains from conscious intervention,

any patient between whom and the analyst there has deliberately been fostered a relation resembling love must intuitively note what gladdens. As to analysts, how could they be unbiased critics of their findings? Obviously only those who incline to the known doctrines of psycho-analysis take it up. They are taught that it is only possible to observe phenomena and to see them in a true light after a suitable novitiate. Yet critics are asked to accept that only those who are thus disposed to belief in the doctrines of psycho-analysis by strong emotional bias and material interests are fitted to discuss them, though often the question which arises does not concern expert observations of phenomena, but is one of logic that would make a lawyer laugh.

(3) As to the requirement that a science should be capable of development on quantitative lines, psycho-analysis makes a unique merit of freedom from this potentiality.

Rickman at the conclusion of his book says: "The tendency of psychiatry up to the present time has been to turn for help to the physical sciences which resolve themselves to number, measure and scales. . . . Psycho-analysis now has to offer another method which does not enumerate, measure or weigh; it deals only with presentations in the mind, how they interact and how they take effect in behaviour."

Galileo doubted whether any idea which did not lend itself to measurement could be regarded with certainty as corresponding to anything outside the mind of the thinker.

It is obvious, of course, that psycho-analysis in enunciating any of its theories (e.g. those about paranoia) makes not the slightest attempt to support these with statistical evidence.

Hart's Plea for the Unconscious Mind of Freud

Of Hart's first paper relevant to the topic of this article, namely, "The Philosophy of Psychiatry," I still hold that the reading of it should be compulsory for the incipient psychiatrist.

Thereafter Hart seems to have gone astray in attempting to prove that Freud conforms to those requirements of science which Hart himself had propounded with such lucidity. It appears that the clue to this acclamation of Freud is that like Jeans and Eddington, Hart is profoundly attached in feeling to universals as realities and is an axiomatic animist. Intellectually he is nominalist enough to admit that the Unconscious Mind is a conceptual device. But he never betrays any awareness that Mind as a whole, or to put it more plainly the Soul, needs defence as a subsisting entity, or that others may regard it as merely a collective term for events. Nevertheless, the crucial question is the legitimacy as a scientific concept not merely of the Unconscious but of Mind in the idealist sense with all consequences which follow assumption of this.

First it is necessary to say, that against accounts of the sequence of consciousness in terms denoting conscious experience and in these alone, *as approximations*, there is nothing to be said. But the conscious and physical correlates of any mental process are one totality. It is not a question of an account of the one or the other being more nearly ultimate, as for example a physical explanation in terms of electrons might be thought more nearly ultimate than a chemical one in terms of atoms: it is rather that an account of both consciousness and behaviour and their correlation are essential for the completeness and finality of any psychology. If so, what merit is there in schemes that foster a lasting segregation in virtue of the fact that the conscious phenomena are eked out and linked by conceptual entities such as could never be correlated with physical equivalents.

Hart's argument for the Unconscious Mind of Freud consists essentially in the plea that it is purely conceptual, but that it makes possible a presentation of psycho-

logical events as a continuum, and so a wholly independent psychology. But who desires such a psychology? To my mind it is as scientific and fruitful to demand that psychology and physiology shall be dealt with as entirely independent sequences, as it would be to idealize a meteorology which ignored astronomy, in which reference to the Earth and Sun were forbidden and in which sequence and combinations of weather which were actually observed, must be referred to the interaction of an entity termed Perceptible Climate with another termed Imperceptible Climate.

Actually Hart's defence is not valid at all for the Unconscious as understood by Freud and his followers themselves. If the Unconscious were just an explanatory device, then clearly the psychologist would be presented with a clean slate on which he could write as the content of the Unconscious whatever met his purpose, rubbing out and re-writing as seemed useful from time to time.

This would be the logical consequence of admitting the Unconscious to be an invention not a discovery. Hart may be defending such an Unconscious Mind that it is entirely formless and devoid of fixed content; if so, it is not the Freudian version. The psychoanalyst will have none of this depopulation of Everyman's private inferno. He peoples the Unconscious with inmates of most definite habits.

Hart recognizes that most Freudians do not join him in regarding the Unconscious Mind as a symbol, device or *façon de parler*. In his address he says, "My psycho-analytic friends, however, have frequently castigated me for expressing this latter view, and stoutly maintain that the Unconscious processes are of precisely the same order as Conscious processes." These we are all agreed are phenomena. Then follows a remarkable sentence. "Probably the difference between us can ultimately be resolved into a question of words without much practical significance."

In his previous paragraph, Hart had asserted that Freud's Unconscious Mind and all its parts were concepts, and that this introduction of concepts marked an epoch and constituted Freud's greatness. Freud and his followers flatly deny that they are concepts, asserting that they have objective existence. This makes of the theory a mythology. Yet we are asked to continue belief in the greatness of the achievement. Surely this is carrying too far the genial theory that we all mean the same thing really.

Alleged Support for Idealism from Physics

Of recent years there has been a tendency for idealists in psychology and psychiatry to look for support to physicists of the same kidney, proclaiming their views as the philosophy of modern science.

Hart quotes with approval this passage from Sir James Jeans: "To-day there is a wide measure of agreement which on the physical side of science approaches almost to unanimity that the stream of knowledge is leading towards a non-mechanical reality. The universe begins to look more like a great thought than a great machine. Mind no longer appears as an accidental intruder into the realm of matter; we are beginning to suspect that we ought rather to hail it as the governor and creator of matter."

What Sir Arthur Eddington stresses is mainly the principle of indeterminacy. The significance attached to this by idealists devoted to scientific defeatism depends on misrepresentation of the real meaning of a technical difficulty and upon a pun. The word "determination" can be used with two meanings, that of causation in the scientific sense or that of ascertainment. The principle of indeterminacy is not truly an assertion of the inherent inconstancy of the events in nature and their lack of adequate determinants, but the confession of our incapacity to predict certain events in terms of such concepts as we have up to date. This may depend on complexity of interacting causes or upon insufficient delicacy of measurement. We have not in some respects reached the capacity to formulate observed events with our present conceptions of space and time.

By Jeans and Eddington we are asked to accept as the philosophy of science the sort of idealism which with all its consequences was set forth by Berkeley and of which (until Jeans and Eddington) he was perhaps the most widely known exponent in this country. Of Berkeley, Bertrand Russell says that he was not only a Bishop, but an Irishman, so we must not be too hard on him. Science has not been swept off its feet by this age-old doctrine. In its favour there seems nothing particularly new, except some misrepresentations based upon punning as to the theological consequences of so-called indeterminacy, and some fresh applications of the principle most popular among savages that what is not understood can always be explained animistically. Bertrand Russell by 1931 had already published a devastating commentary on these views of Eddington and Jeans. As he says, Eddington deduces religion from the fact that atoms do not obey the laws of mathematics; Jeans deduces it from the fact that they do.

Repudiation of Subjective Idealism by Experimental Physicists

The mutually contradictory arguments by which Jeans and Eddington lead us back to the revealed doctrines from which they obviously started, have of course obtained a wide popular vogue as the conclusions of science.

What of the claim to the almost unanimous agreement of other physicists? This claim surely breathes the spirit rather of the pulpit and the political platform than of the laboratory and the lecture room. Democracy has not so far pervaded physics as to have established the referendum as the criterion of truth. Meanwhile, in view of the aristocratic temper which prevails in science, it seems careless to have overlooked Einstein, Max Planck and Lord Rutherford. The reply has not been long delayed. In "Where is Science going," Einstein explicitly describes the idea that he agrees with the subjective idealism championed by such modern scientists as Eddington as being ridiculous. Further, he writes:—

"You must distinguish between the physicist and the littérateur when both professions are combined into one. In England you have a great English literature and a great discipline of style. What I mean is that there are scientific writers in England who are illogical and romantic in their popular books, but in their scientific work they are acute logical reasoners."

Again Einstein says:—

"We must distinguish between what is a literary fashion and what is scientific pronouncement. These men are genuine scientists, and their literary formulations must not be taken as expressive of their scientific convictions. Why should anybody go to the trouble of gazing at the stars if he did not believe that the stars were really there?"

As to determinism, Einstein says:—

"Much of the misunderstanding encountered in all this question of causation is due to the rather rudimentary formulation of the causal principle which has been in vogue till now. I believe that events in nature are controlled by a much stricter and more closely binding law than we suspect to-day, when we speak of one event being the cause of another. Quantum physics has presented us with complex processes, and to meet them we must enlarge and refine our concept of causality.

As to indeterminism, Einstein says:—

"The indeterminism which belongs to quantum physics is subjective indeterminism. I am entirely in agreement with what Planck has said and written. He admits the impossibility of applying the causal principle to the inner processes of atomic physics in the present state of knowledge. But he has set himself definitely against the thesis that from this inapplicability we are to conclude that the process of causation does not exist in external reality. And when you mention people who speak of such a thing as free-will in nature, it is difficult for me to find a suitable reply; the idea is of course preposterous."

The claim of Jeans to unanimous agreement with his subjective idealism is so far from true that the greatest physicists living, while aware that they have no *direct knowledge* of anything but their own conscious processes, profess a *personal belief*, recognized as such, in the existence and in the objective determinacy of external events which these conscious processes do not mirror but betoken. As to this, of course it should be said that it does not amount to a belief that their current physical concepts, such as atoms or electrons or quanta, necessarily have objective existence or are other than the most convenient symbols so far devised for expressing the sequence of processes.

Theological Implications of Animism

It is accepted by everyone who has seriously thought about it that absolute idealism or panpsychism is a logically inevitable corollary of every form of animism: in words of one syllable, as soon as one says that to sum up the facts one needs a soul, one is bound to bring in a God as well. If so, can the concept of animism be tolerated as part of the method of science with its limited objective? As concepts of science, both Soul and God are utterly destructive of the causalism that is its essence. Hart himself has quoted Galileo's saying: "The Will of God explains nothing, because it explains everything."

Standing alone, subjective idealism is an absurdity, a sort of collective solipsism. If the universe only existed as processes of the human mind, there could be no question of a universe proceeding or outlasting human thinking. As to this, of course, the usual view is more nearly expressed by the description of human history as a brief and discreditable episode in the life of a minor planet. The whole of science obviously points to the conclusion that only after the universe had undergone an evolution of unimaginable duration could the mind of man have arisen. The only answer of a purely subjective idealism to this quandary would be to suppose that science is nonsense, that the appearance of an evolution preceding man is itself an illusion of the human mind. If so, what evidence would there be that the apparent sequence of events since the origin of human consciousness was not equally illusion of the uttermost kind?

Absolute idealism transfers responsibility for existence to the Mind of God making the Mind of humanity a part of this. Eddington and Jeans, having recognized the needs of subjective idealism, manfully took the theological plunge. Eddington closes a chapter with the statement that modern physics can be summarized in the formula, "And God said let there be light." The absolute idealism of Jeans is thus expressed: "We have already considered with disfavour the possibility of the universe having been planned by a biologist or engineer; from the intrinsic evidence of his creation, the Architect of the Universe now begins to appear as a pure mathematician."

Here the psychiatrist will recognize with amusing simplicity the mechanism projection. It is a long way from Jehovah to super-Jeans and the journey has taken over 3,000 years, but nothing could better exemplify the slowness of evolution than the constancy of the mechanism which gave us the vindictive oriental tyrant of the earlier scriptures and now gives us the Great Mathematician of 1930.

Scientific Defeatism

The idealists who believe, contrary to Einstein, Planck, Rutherford and others, that indeterminism is not a measure of our ignorance, but inherent in events, proclaim now a limitation to the province of inductive science, as this has always been proclaimed by the religious. Jung is particularly emphatic concerning the limitations of the scientific method in psychology. Hart says that we must realize that

the method of science is not a unique key to knowledge and that no responsible scientist would dream of making such a claim.

I think this double assertion may at once be disputed. It may well be questioned whether there is any alternative method if we distinguish belief from knowledge and unless we grant the power of revelation or intuition to provide knowledge as opposed to belief. Hart writes as if mathematical formulations were an alternative to an inductive science; they are supplementary and suggestive of further inductive work, but never alternative. A mathematical formulation (such as the periodic table) may suggest the search for missing elements, but can never find them. Mathematics may present phenomenal facts in a new pattern, but by mathematics one can no more acquire knowledge of phenomenal fact than one can create coloured glass by rattling the kaleidoscope. This applies to psychology as much as to geology.

Possibility of a Nominalist Psychology

Banishment from scientific psychology of mystical subsisting entities, Souls and Minds (whether conscious or otherwise) by no means banishes the possibility of a science of consciousness. On the contrary it creates it. The true aim should be a psychology which has no more connexion with animism than has geology or than, in the hands of its experimental workers, has modern physics. Psychology should be as far as possible constructed in bare terms of perceptible events. When concepts are introduced, either they must be of the verifiable type or their nature as collective symbols should be declared beyond doubt. Conscious events whether in ourselves or others are equally phenomena, if we disregard solipsist quibbles. Such phenomena are equally material for scientific treatment, whether they appear to be immediately referable to some external source or not. A scientific psychology would regard causalistic description of the sequence of processes of consciousness and of behaviour and of the attempt to correlate these as its triple objective. Any account of such sequences would of course persistently represent the two sets of phenomena as empirically correlated in an unknown way. It should not be framed in terms in which sensations are said to reside or occur in the cortex; equally it should not be said that behaviour made up of objective processes is determined by volitions, i.e. subjective events.

We are confronted with a problem of definition: what are the limits to which the term "behaviour" is applicable? It may be suggested as the best working basis for psychiatry: (1) That the term "behaviour" should be used to connote reactions, involving a synthesis that is or formerly was accompanied by consciousness; (2) that with this may be coupled the complementary view that consciousness is always and only awareness of behaviour, i.e. awareness of happenings of a certain synthetic complexity in one's own body and can be nothing else. This view of course differs entirely from the extreme form of behaviourism which adopts the attitude that after the description of behaviour there is nothing left to describe or worth description, that consciousness either does not exist or the less said about it the better.

Continuity of Neurology and Psychology

I wish now to suggest as the greatest need of normal and morbid psychology emphasis on their continuity with neurology (using the term to cover psychology as well as pathology of the nervous system). Here one comes to an outstanding difference between the animist and nominalist school in psychiatry. It has been said by a well-known English psycho-analyst that the special study of neurology should form no part of the training of a psychiatrist.

Hart defined psychology as "An attempt to explain the behaviour and mental

processes of a patient by conceptions built out of the stuff of subjective experience." But it is impossible to explain behaviour which is a sequence of objective phenomena in terms of subjective experience or of conceptions built out of their "stuff." This limitation of the term psychology would exclude behaviour entirely from its scope.

Later Hart said:—

> "The researches of Pavlov, and the immensely important conceptions to which they have led, belong to the sphere of physiology and the behaviouristic psychology, which has been built on these conceptions, is not psychology in the sense in which the word is employed in this address. It does not attempt to interpret phenomena in terms of subjective experience; on the contrary it expressly declines to have anything to do with subjective experience and constructs its conceptions on a mechanistic stimulus-response system, which is clearly and entirely couched in the language of physiology."

It must be remembered that Pavlov's researches do not concern only internal components of behaviour innervated by the vegetative nervous system, such as salivation, but also the excitation and inhibition by stimuli of such reactions as the "defence reflexes" (e.g. the rejection of a substance from the mouth) and the "investigatory response" (e.g. raising the head and pricking up the ears to catch sounds). With these there is every usual reason to suppose that consciousness is associated. If these responses are not the business of psychology, then behaviour is none of its business.

Watsonian behaviourism, which was an attempt to apply Pavlov's principles in psychology and psychiatry, failed because of certain gratuitous exaggerations. These vitiated behaviourism, but it had merits. Among these were its insistence on strict objectivity and on the principle that what we term consciousness is awareness of responses of our own bodies (which may be only incipient). To my mind Golla's work strongly supports that aspect of behaviourism. Hart in defining psychology seems to err in a manner diametrically opposite to Watson. The study of behaviour is part of the triple task of psychology and at the same time the business of the upper reaches of neurology. Here the two sciences merge and become indistinguishable as do physics and chemistry. Further, continuity and comprehensiveness demand that the explanation of the objective facts of behaviour, both normal and abnormal, shall be framed as far as possible as an upward continuance of those principles (reached by observation, experiment, and induction) which account for responses mediated by lower levels of the nervous system. As a matter of observation the analogies are obvious. It is hard to idealize a theory that makes of these analogies a meaningless miracle. But to the extent that it is admitted that they are more, we have a confession that determination of the form of normal responses or of symptoms is a function of the constitution of the central nervous system. How then do without neurology? For my part I venture to think that the ancestors of the psychology of the future will be such investigators as Hughlings Jackson, Sherrington, Head, Pavlov, and Lashley, rather than Freud, Jung and Adler.

Because of their objectivity and amenability to formulation of their sequences in terms of verifiable hypotheses, the facts of behaviour lend themselves better to scientific investigation than do those of consciousness. Theories covering behaviour almost necessarily involve induction of formulæ covering likewise reactions at lower levels. Such formulæ seem capable of submission to the sort of crucial tests which are essential. Tracing, in this manner, analogies and differences between activities mediated by different levels of the nervous system seems more likely to be fruitful than speculations in terms of an isolated conscious series which cannot be put to any test. It is with full knowledge of their speculative quality that I suggest in a tentative way sample hypotheses couched in neurological terms and representing possible alternatives to accounting for the form of symptoms in terms based on the assumption of interaction between conscious and unconscious mind.

If we search for formulæ couched in terms of process rather than of alleged subsisting entity and covering alike: (1) combination and sequence of physical symptoms in organic nervous disease; (2) combination and sequence of anomalies of behaviour and its conscious correlates, then the first and most obvious principles offering in outline a general explanation are those of Hughlings Jackson. These include the principles that ontogenesis recapitulates phylogenesis, that devolution reverses evolution (both ontogenetic and phylogenetic), that there is always a combination of facilitation and control in all action mediated by the central nervous system and in consequence that there are always deprivation and decontrol symptoms as the result of any lesion of it. Some of these principles anticipate in exact words some of the metaphors of Freud. Applicability of such principles is one difficulty of animistic theories of neuroses and psychoses. Another is the frequent identity of syndromes caused by the grossest organic lesions with those which (as a cloak for ignorance) we term functional.

Deprivations.—Can the deprivations which follow impairment of the highest mental level be analysed into components for which a structural basis might reasonably be sought? Spearman's work may afford a clue worth following. He gives a list of ten kinds of relations, the discriminations of which are the elements constituting the whole process of cognition. He says: "Of these relations, three are ideal, being those of resemblance, evidence and conjunction. Seven are real, those of space, time objectivity, identity, attribution, causation, and constitution." A very similar classification of elementary cognitive discriminations is to be found in "Pragmatism" by William James. Systematic analysis of the efficiency of such discriminations in psychiatry seems worth while (if practically applicable tests can be devised) and might well be correlated with anatomical studies in cases where defect in one or other element is outstanding.

Among the commonest features of mental disorder is the failure in some degree to discriminate between the outer world and what is and pertains to the self (introjection and projection in the limited psychiatric sense). The forms and degrees of such error are legion. The reduction of capacity to make the judgment is obviously due to a physical factor, e.g. alcohol or infectious toxæmia in many cases. But we know hardly anything of the physical basis or of the data of correct judgment. Such problems can only be solved by abandoning speculation, except as a starting point to be supplemented by the most painstaking and critical observation of phenomena.

Decontrol.—Balances and coördinations normally obtain between functions at any one level of the nervous system. These modes of balance and coördination can be classified under certain general headings: some at least of such general headings of classification (e.g. "reciprocal innervation"; "projection") will be found applicable at various levels of the nervous system, including the mental levels. At each level alike it is possible to classify some symptoms as errors of this or that mode of balance or coördination and so to trace an analogy between symptoms at different levels. Failures of control from above are apt to lead to maladjustments which can be analysed as composed in varying measure of these standard modes of deviation. A hint of the meaning intended by these dark generalities may perhaps be conveyed by examples.

Reciprocal innervation and contract.

This is illustrated alike in the spinal reflexes and in the movements mediated by the cortex; on the motor side, chorea and athetosis appear to be due to defect of such reciprocal control between movements of cortical origin.

Much that occurs in psychiatry suggests existence of reciprocal innervation between the processes that form its province and also that disturbance of this may be the nature of symptoms commonly ascribed to decontrol.

It seems to be a general rule that emotional mechanisms exist in pairs (comparable to innervation of agonist and antagonist muscle-groups or to the neural bases for vision of complementary colours) and that between the pair reciprocal innervation obtains. In fact it is probable that, just as in voluntary movement combination of reciprocally innervating agonist and antagonists, synergic action, associated movements, and movements of coöperation are required, so for balanced emotional response coördination of several emotional mechanisms is necessary, not the simple activity of one.

Consideration of these principles might throw light upon such psychiatric facts as ambivalence, obsessional doubt, and some emotional oddities of the schizophrenic. Though some of these are individually conditioned by specially significant experience, it may be unduly elaborate to suppose that they are so in every case. Some might be more analogous to chorea.

Between neural processes on the afferent side, there appears to exist an adjustment analogous to that termed "reciprocal innervation" on the efferent; this adjustment underlying the occurrence of contrast, whether simultaneous or successive (as exemplified in colour vision, among many instances).

The analogies between the phenomena of contrast and those of ideational overcompensation, as seen in grandiose delusions, are too obvious to need labouring. The same principle may possibly be exemplified in the precipitation of "Laughter in court," of the shrieking merriment of the thwarted hysteric and of reactive mania. A study of the general principles governing appearance of contrast phenomena and the prevention or termination of these might be of value.

Faulty projection.—If one uses the term Projection, not in its limited psychiatric sense, but to mean reference of any afferent stimulus to its source and adaptive reaction according to its source, then faulty projection is illustrated at many levels in terms of purely objective response. It is exemplified by the retention of urine which may follow operation on the anal canal and by the erection which is prone to occur (especially in sleep) with a full bladder and which may lead to emission and erotic dreams. There is a transition from such impersonal phenomena via all that has been observed concerning more individual conditioning of responses, to higher objective anomalies, such as schizophrenic mannerisms, tics, compulsive acts (including sexual perversions) and so to irrationalities which more or less unwittingly everyone of us daily performs.

If we look rather to the subjective than to the objective side of the same matter, we could perhaps trace the same continuity in principle from reference of visceral stimuli to the somatic, instead of the splanchnic, territory of a given spinal root, to reference of pain from a diseased hip to a healthy knee and so up through conditioned affective reponses, phobias and other obsessive emotions to the more complex prejudices which all of us feel with insight varying according to our current endowment of humour. Any obscurity in the analogies depends largely on the fact that at lower levels even the errors are dependent on innate connexions, and standardized, while, increasingly with ascent of the nervous system, symptoms become post-natally conditioned and thus individual.

In the above discussion of faults of reciprocal innervation and of projection, errors in a certain direction have been regarded as analogous regardless of time-relations, especially regardless of duration. This seems justified, although the reasons for such time differences are themselves problems of the first importance. Probably they are due in part to constitution of lower and higher levels of the nervous system, in part to factors external to it.

Passing to individual features of syndromes, the work of Pavlov goes far to explain these and in my opinion, though difficulties exist in its application to man,

steady painstaking work on similar lines is the most promising foundation for a rational psychopathology and psychotherapy of the future. Pavlov fully recognizes the existence of individual differences, both permanent and transient, in the character of the responses determined by conditioning in different dogs. Thus there is every facility for introducing into ætiology all sorts of other factors as well as the stimulus or experience—a soil as well as the seed. Pavlov has shown how, by what may reasonably be termed mental conflict, conditions resembling psychoses can be induced and how these vary according to the personality of the dog.

As to individual symptoms (obsessions and symbolisms of all kinds) more understanding is obtainable from consideration in the light of Pavlov's principles than in any other ways. Finally, his principles indicating the modes of conditioning and inhibiting particular responses correspond largely to the sort of rival methods in psychotherapy which have prevailed from time to time. This suggests the possibility of experimental work to determine accurately the province and efficacy of each such method.

Here it is necessary to say that human thinking cannot be totally explained without residue in formulæ summarizing what is seen in connexion with the establishment and inhibition of conditioned responses in laboratory dogs by overt repetition of stimulus and reaction. But this is as true of Kohler's chimpanzee and the orang-outang of Yerkes as it is of man. These apes show adaptive reactions prior to overt trial and error. In other words, they act apparently from pure reason. This was traditionally ascribed to the Soul. Comforting as these observations may be to opponents of extreme behaviourism, they reduce further the place in science of the soul, unless animists are prepared to claim the distinction of sharing a soul with chimpanzees and orang-outangs, but not with dogs.

There is good reason to believe that what we call reasoning is also a process of trial and error, but carried out symbolically by nascent reactions instead of overtly. If so, it would be easy to conceive such symbolic reactions as the function of another level of the nervous system with which empirically the conscious aspect of reasoning was correlated. The metaphysical problem of this conjunction of objective and subjective would, of course, remain untouched.

A little attention to current principles of neurology would, by legitimate analogy, tend to lessen beliefs current among psychiatrists in the fallacies of the single cause, the solitary syndrome, the standard course and the specific cure. Take sleep as the paradigm of all conditions in which reduction of activity occurs in those levels of the central nervous system with which consciousness is associated. Sleep may be induced in many ways. In any case the result is much the same, and probably because for sleep the requisite is that a particular mechanism shall be either activated or inhibited. What is true of sleep (which might be called either a neurological or psychological syndrome) is probably true of any clearly psychopathic syndrome.

Neurology illustrates abundantly the following principles:—

(1) Any one mechanism responsible for a characteristic syndrome may be affected by one of many nocuous factors (as in the epilepsies, the choreas, the Parkinsonisms).

(2) Any one nocuous factor may in a single case or in different cases affect several mechanisms, i.e. produce several syndromes (e.g. in epidemic encephalitis, in neurosyphilis, in amyotrophic lateral sclerosis).

(3) The influence of one nocuous factor may render a mechanism susceptible to the influence of a second, and such complexity and multiplicity of cause is so common as to be almost the rule. The precipitation of acute symptoms by physical or emotional exhaustion in disseminated sclerosis or by injury in general paralysis are examples.

(4) There is such complex reciprocal connexion between each neuron system and others (e.g. between pyramidal, striatal, cerebellar and rubrospinal) that a lesion affecting primarily one such system inevitably causes repercussions in a number of others, even in the absence of any direct operation of the nocuous factor on other systems.

For the last reason alone, apart from any other, it is hardly conceivable that a neurological syndrome can be pure and the same is true of psychiatric syndromes.

Neglect of the lessons of neurology results, for psychiatry, in a textbook isolation of syndromes that is fantastically remote from anything seen clinically and in a search for unitary causes and unitary cures of such syndromes which is as naive and as futile as the quest for the elixir of life. This is general admitted in respect of what are termed psychoses, but the psychotherapist stops when the sacred distinction between neuroses and psychoses is endangered. This is a wholly false antithesis. The defenders jump about from a general admission that commonly there is coöperation between psychogenesis and other causes (heredity, epochs, physical influences) to an attitude that neuroses are completely explained without residue by such theories as those of Freud, and that certain psychoses, though totally different, will be so explained later. The occurrence of one of the syndromes known as neuroses in pure form and entirely psychogenic is possible to conceive. As a clinical fact it is probably much rarer than occurrence in nature of a pure element unmixed and uncompounded.

Every syndrome, whether neurotic or psychotic, so far as isolation is justified at all, corresponds to a reaction pattern of the organism, and each such reaction pattern can be impaired, released or overactivated for a multitude of reasons, some "functional," others "organic."

There is little doubt that dimly, perhaps secretly, most of those drawing definite distinctions between neuroses and psychoses are influenced by animist ideas, by beliefs that in neurosis a disordered mind is acting through an intact body or through a body that is only disordered in a secondary and transient way. In fact, to patients and to lay audiences they will openly say that neuroses are disorders of the mind, not of the body. This is, of course, as absurd as the contradictory distinction about the same conditions, "It's not his mind, it's only his nerves." But serious practical issues, such as the efficacy of psychotherapy alone in producing permanent cures depend on whether these animist views are correct. If not, if neuroses are all comparable to conditioning, it may be taken as certain that permanent liabilities will survive any such method.

Development of Research in Psychiatry

It has been widely suggested that the number of those suffering from psychological disabilities which could be medically helped is about ten million cases in Great Britain, there being about 60 or 70 minor cases for every major one. For the cases, though minor in severity, which form the large majority in number, some seem to hold that there is no effective treatment but psycho-analysis. Personally I cannot believe that the task of the next generation is the spread of psycho-analysis among the lower classes. It would seem cheaper, following Harvey, to seek out the secrets of human nature by way of experiment. So far expenditure is grossly improvident in this respect. The needs of psychiatry are simple and only two—men and money. Money-getting is, of course, no topic for a contribution like this, so the discussion can be almost limited to that of getting men. What is wanted in psychiatry is what was recognized as the need of general medicine by the late Sir Walter Fletcher.

The first point to emphasize is that opinion concerning psychiatry in England is far too largely formed by those in practice. Therefore, not only is it unduly optimistic, but of a kind which dispenses with the laborious observation and experiment that forms the basis of every progressive science. It must be recognized that under modern conditions really important research cannot be a hobby for the leisure of those in either institutional or private practice. The army of science cannot be a militia; techniques are too difficult. Likewise it cannot be entirely a short service army. There is in England (or probably could be found) as much money for research fellowships in psychiatry tenable during a year or two as is needed for any available men upon whom money could profitably be spent in this way; there is a deplorable lack of long-term endowment of research.

The same was found to some extent in general medicine. Here at least those who had done brief research went out into private practice with added prestige and greater chance of a hospital post. There is no hope of any such reward in psychiatry, and indeed many of those who would serve it best in the laboratory are not well suited to wards or consulting-rooms. Men are needed for whom research in psychiatry shall provide a career comparable with that which their fellows of first-class ability achieve in practice; a career at least providing the chance of giving their children as good an education as themselves. Such men will have to be paid to do research only, interrupted by nothing but the training of other research workers, protected against overloading with elementary teaching. At present there are, so far as I know, only one or two such posts in this country; hence the shortage of light and leading.

In general medicine there is a steady movement in the direction of creating such positions. Results from the units at certain teaching hospitals had been rather disappointing because the leaders of them have been overloaded with elementary teaching. To overcome this there have been founded at University College Hospital one post financed by the Rockefeller Foundation, at the National Hospital another financed by the Medical Research Council, to provide real careers for men doing nothing but research and the direction of this. Power has been taken to divert some of the income of the Beit Trust from payment of short-term fellowships to provision of similar careers in research. This is only a beginning in general medicine and it is the sort of thing we cannot afford not to do on a large scale in psychiatry. £50,000 a year would go quite a long way. We need at leading Universities about half a dozen Institutes of Psychiatry with access to early cases. These should be comparable to such an organization as the School of Agriculture at Cambridge, to which the Rockefeller Foundation gave, I believe, half a million pounds. Each Institute of Psychiatry should provide careers for half a dozen real experts in branches of science relevant to psychiatry, in psychology of the right type, in anatomy—especially of the experimental kind—in physics, in biochemistry, in genetics and in sociology.

Personally I think there should be no attempt to look for the holders of most of these positions in the ranks of psychiatrists, because it is certain that men with knowledge of the frontier of one of these sciences will not also be a psychiatrist. But I think each of those selected for knowledge of a particular science should have a training for a year or two in psychiatry, so that he shall have a live feeling about its real problems. Last, but certainly not least, in the team would be a fully trained and expert psychiatrist in active charge of a large number of patients, who would check the ever-present danger upon which Sir Walter Fletcher insisted of laboratory research growing academic and remote, and concerning itself with problems that may be significant next century. It is vital that there should be several such institutes, so that opinion may never be dominated by one school of thought. I would even have one specially for animists if only they could be induced to accept sufficient

publicity. Thus we should keep that combination of private acrimony with public urbanity which is so stimulating.

I put this forward as a programme, not a fantasy, as an alternative to the unquestioning expenditure of ten millions a year. There is provision for it in Clause 6 of the Mental Treatment Act, 1930.

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A Clinical Study of Delirium

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[AUTHOR'S ABSTRACT]

SYNOPSIS.—The study is based upon 103 cases, which have been observed at either the Phipps Psychiatric Clinic or the Maudsley Hospital; twenty-seven different ætiological agents are represented. The following questions are raised:—

(1) Whether there is evidence that different ætiological agents produce specific or even characteristic delirious states. (2) In what ways are the ætiological agents directly related to the states they produce. (3) What other factors help to determine the clinical picture. (4) What are the characteristics which these states appear to possess in common. (5) What light may this shed upon the rôles of exogenous as opposed to endogenous factors in the production of mental disease.

The symptomatology, as recorded, is briefly sketched and some cases to illustrate particular points are given.

It is advanced, on the observations made—with a clear realization that different and more detailed study might come to quite other conclusions—that:—

(1) Nothing was found to suggest that any ætiological agent bore a truly specific relationship to the delirious state it produced.

(2) The delirious states produced appeared to be directly related to the ætiological agent, and could be considered characteristic of them, in so far as the ætiological agent tended to affect the intensity and duration and "stability" of the functional disturbance in a fairly uniform manner.

(3) The final clinical picture was also strikingly dependent upon the previous personality of the subject, and upon environmental stimuli sustained during the period of illness.

(4) The nature of the functional disturbance which all these cases had in common had two aspects: (*a*) a decrease in the ability to discriminate and differentiate, "confusion," a deficiency in just those qualities for whose proper exhibition the integrity of the cerebral cortex is generally considered to be necessary, and (*b*) an increased activity of a type bearing close resemblance to the dreaming state.

(5) Finally, it is argued that it is highly improbable that in psychoses which do not show "confusion," exogenous factors are likely to play more than a subsidiary, though in certain instances none the less an exceedingly important, rôle. Thus a study of exogenous reaction types might help to a better perspective in such debated issues as the importance of "focal sepsis" and the speculative toxæmias in the production of mental disease.

RÉSUMÉ.—Cette étude est basée sur 103 cas observés à la Phipps Psychiatric Clinic ou à Maudsley Hospital, 27 agents étiologiques différents étant représentés. Les questions suivantes sont posées:

(1) Y a-t-il de l'évidence que les différents agents étiologiques produisent des états de délire spécifiques ou même caractéristiques? (2) Quels sont les rapports directs entre les agents étiologiques et les états qu'ils produisent? (3) Quels autres facteurs contribuent à la production du tableau clinique? (4) Quels caractères paraissent être communs à ces états? (5) Quelle lumière est jetée par ces faits sur le rôle des facteurs exogènes en contradistinction aux facteurs endogènes dans la production des maladies mentales?

Courte description de la symptomatologie notée, et de quelques cas illustrant des questions spéciales.

On avance que, d'après les observations faites, et se rendant compte qu'une étude différente et plus détaillée pourrait mener à d'autres conclusions:

(1) Rien n'a suggéré qu'un agent étiologique quelconque possède un rapport réellement spécifique avec l'état de délire produit par lui.

(2) Les états de délire paraissent être en rapport direct avec l'agent étiologique, et peuvent être considérés comme caractéristiques de cet agent en tant que celui-ci a une tendance à influencer l'intensité, la durée et la "stabilité" de la perturbation fonctionnelle d'une façon assez uniforme.

(3) Le tableau clinique définitif dépend aussi d'une manière frappante de la personnalité antérieure du malade, et sur les stimuli de l'entourage auxquel il est soumis pendant sa maladie.

(4) La perturbation fonctionnelle commune à tous ces cas présente deux aspects: (*a*) une diminution du pouvoir de discernement et de différentiation, de la "confusion," une faiblesse des qualités pour lesquelles on considère généralement que l'intégrité du cortex cérébral est nécessaire; (*b*) une activité augmentée, ressemblant beaucoup à l'état de rêve.

(5) Enfin on soutient qu'il est très peu probable que les facteurs exogènes aient un rôle plus que subordonné, quoique quelquefois très important, dans les psychoses sans "confusion." Par exemple, une étude des types de réaction exogène pourrait aider à obtenir une meilleure perspective dans des questions très discutées, telles que l'importance de l'infection focale et les toxémies spéculatives dans la production des maladies mentales.

ZUSAMMENFASSUNG.—Diese Arbeit ist auf 103 in der Phipps Psychiatric Clinic oder in Maudsley Hospital beobachteten Fälle begründet. Es sind 27 Krankheitserreger repräsentiert. Die folgenden Fragen sind erhoben.

(1) Gibt es Beweise dass verschiedene Ursachen spezifische oder charakteristische Delirien bedingen? (2) Welche Zusammenhänge gibt es zwischen der Krankheitserreger und den hervorgerufenen Zuständen? (3) Welche andere Faktoren wirken in der Entstehung des Krankheitsbildes mit? (4) Welche Eigenschaften sind diesen Zuständen gemein? (5) Wie kann dies die Frage der Rolle der exogenen im Gegensatz zu den endogenen Faktoren in der Entstehung von psychischen Krankheiten beleuchten?

Die Symptomatclogie ist kurz beschrieben und einige Fälle die besondere Punkte illustrieren mitgeteilt.

Während Verf. sich völlig bewusst ist dass verschiedene und mehr ausführliche Untersuchungen auf ganz andere Schlüsse veranlassen könnte, bringt er die Meinung vor:

(1) Dass es kein Anhalt dafür gibt, dass ein spezifischer Zusammenhang zwischen der Krankheitsursache und dem durch sie bedingten deliranten Zustand besteht.

(2) Dass die hervorgerufene Zustände insofern mit der Krankheitsursache zusammenhängen und von ihr charakteristisch sind, dass diese die Stärke, Dauer und "Stabilität" der funktionellen Störung ziemlich regelmässig beeinflussen.

(3) Dass das definitive Krankheitsbild auch in auffallender Weise von der vorhergehenden Persönlichkeit des Kranken, und von den Umgebungsreizen denen sie während der Krankheit ausgesetzt sind, abhängt.

(4) Dass die funktionelle Störung die allen diesen Fällen gemein ist zwei Seiten zeigt: (*a*) eine Herabsetzung der Diskriminations- und Differentiationsfähigkeit, "Confusion," Unzulänglichkeit von den Fähigkeiten die nach allgemeiner Ansicht für ihre richtige Äusserung die Unverletztheit der Hirnrinde erfordern, und (*b*) eine erhöhte Aktivität von einem dem Traumzustand sehr ähnlichen Typ.

(5) Endlich wird es erörtert dass es sehr unwahrsche inlich is dass die exogenen Faktoren in den Psychosen ohne "Confusion" mehr als eine untergeordnete Rolle spielen, obwohl diese sehr wichtig sein kann. Eine Studie der exogenen Reaktionstypen könnte zu einer besseren Ansicht über bestrittene Fragen, z.B. die Bedeutung der "fokalen Sepsis" und der spekulativen Toxämien in der Entstehung von psychischen Erkrankungen helfen.

IT is customary to classify mental disorders under the two main headings of functional and organic, and to distinguish among the latter those cases which show an irreversible alteration in—or actual destruction of—brain tissue, from those which do not. No single term appears to be in general use to designate all the members of this second class; but it is usual to employ the term delirium for a well recognized, if not perhaps sharply defined, group lying within it which is characterized, amongst other things, by considerable confusion and disorientation.

The records of the 103 cases upon which the study was based were made at either the Phipps Psychiatric Clinic or the Maudsley Hospital. Certainly four-fifths of them would have been unquestionably diagnosed during some period of the illness as suffering from a condition of delirium; about the remainder there might have been argument. In three-quarters the period of maximum disturbance was over in less three weeks.

The group was not a selected one, the only criteria used being that the cases should have been well worked up, and should represent a considerable variety of ætiological agents (27 in all). The largest groups were alcohol, 23 cases; alcohol complicated by some other factor such as heart failure, 7 cases (total alcoholic, 30 cases); heart failure, 9 cases; post-operative, 9 cases; bromide, 7 cases; hyperthyroidism, 4 cases; trauma, 4 cases; chorea, 4 cases, and other fevers and infections, 11 cases. There were, in addition, one or more examples of poisoning by barbital, medinal, copper and lead, and of delirious reactions, due to such varying causes as uræmia, diabetes, eclampsia, hydrophobia, pernicious anæmia, pellagra, encephalitis and cerebral syphilis. Four cases of epilepsy were included, but the legitimacy of their inclusion was perhaps doubtful.

The case records, which were embarrassingly full and detailed, and which were all made in the course of routine by a number of different observers over a series of years, were examined with a view to determining whether records made in this way threw light upon the following questions.

(1) Whether there was evidence that different ætiological agents produced specific or even characteristic delirious states.

(2) In what way the ætiological agents appeared to be directly related to the states they produced.

(3) What were the other factors which helped to determine the clinical picture.

(4) What were the characteristics which these states appeared to possess in common.

(5) What more general deductions appeared permissible, as a result of the study of these frank "organic" reactions, as to the roles of exogenous as opposed to endogenous factors in the production of mental disease.

A sharp division of responsibility between two such rival competitors as "mental" and "physical" was naturally held to be very artificial, and particularly unfortunate in view of the constitutional element, often somehow omitted in this false antithesis. It did, however, seem reasonable to infer that from the presence or absence of mental symptoms of known "organic" type, the correct assessment of physical findings would become more possible, and indications might be reached as to whether they were merely coincidental, or of definite ætiological significance. Further, knowledge of "organic" mental symptoms should arouse suspicion and lead to a successful search for relevant physical factors in those cases in which such disorder was not so apparent.

The features which all these conditions appeared to have in common were confusion and restlessness. In addition, unless the disorder was so profound as to result in a state bordering on or passing into coma, the clinical picture was liable to rapid and frequent variability and change. The patients were very suggestible, or at least responded to stimuli arising both from within their own bodies and from the outer world, with abnormal facility and intensity. They very frequently suffered from visual hallucinations, and almost invariably from delusions or misinterpretations of paranoid type.

By confusion was meant difficulty in grasp and clouding of consciousness. This was invariable, but very fluctuant, and naturally was most clearly demonstrated in tests directed towards the memory, powers of retention, calculation, etc. (the "sensorium").

The restlessness ranged from the most highly coördinated and apparently purposive movements down to the most simple movements, barely, if at all, distinguishable from tremor.

Investigating and occupational activities were very frequent, the former being present in about one-third of the cases, the latter in twelve instances. Neither were specially present in any group. The investigating activities, often to be looked on as attempts at reorientation, merged into the occupational (as in the case of a tailor

who searched for his imaginary scissors to cut the imaginary cloth he had been sewing), and these again into more complicated dramas (as in the case of a man with a police record who thought he was about to be put "on the spot"). In the more complicated dramas of this kind, many activities were clearly a reaction to delusional ideas, or hallucinatory and illusional experiences, the more dramatic in the form of fear, flight and fright.

The mood most frequently found was a dreamy dazed state, very unstable, and merging—or rapidly being transformed—into irritability, excitability, apprehension and frank fear. This last was examined in more detail, and the cases were divided into three groups: (1) great fear, 14 cases; (2) what might be called "average fear"; and (3) fear not strikingly present, or absent when it might have been expected (as on the sight of a hallucinatory snake in the bath beside one), 12 cases. There did not appear to be any connexion between the presence or absence of fear and the ætiological agent, but there did appear to be a connexion between its presence or absence and the previous personality of the sufferer.

It was often easy to see how misinterpretations became the starting-point of delusional beliefs, or became woven into, and helped to fortify, those already present. Just as with the numerous examples of mistaken identification of objects in the environment (sheets mistaken for trousers), sensory misinterpretations (such as a painful backache attributed to a snake bite), shared with the examples of mistaken identity (doctor thought to be a priest), a common origin in expectation or fear. As with confabulation, or that frequent symptom closely allied to confabulation, the prospective important appointment (to arrange business matters or keep an assignation, given as a reason to leave the hospital), none of these manifestations appeared to be confined, nor indeed to be specially common, in any particular group.

Visual hallucinations, many of them obviously having an illusional basis and frequently animal in content, were recorded in 72 cases. Like examples of macropsia and micropsia (one patient had the surprising experience of seeing an 18 ft. Jew) there seemed nothing specific. There were examples of macropsia and micropsia both recorded in the same illness; there were examples of one being present on the first admission, the other on subsequent admissions; and of both resulting from a variety of different ætiological agents.

Auditory hallucinations were recorded in forty-four instances. "Third person discussion," the voices of relations, direct accusations and threats, more vague voices, bells and music, all again were recorded in the most varying cases as regards cause. Unpleasant tactile sensations, such as bugs crawling, were found in alcoholic, cardiac, choreic, traumatic, eclamptic and infective cases. Cases of bromide intoxication, eclampsia, chorea, and infection complained of unpleasant smells.

The delusional ideas were most often transient and ill-systematized; unpleasant possibilities merged into definite beliefs, which would be put forward to be retracted almost in the same breath, and subsequently forgotten or denied. It was hardly stretching the legitimate use of the term to say that every case showed paranoid tendencies (meaning by this a resentful sense of a hostile environment), and that in the vast majority this was at some time or other crystallized into a definite paranoid statement, and went beyond an uneasy sense of perplexity, doubt, or puzzle over the apparently strange things that were happening, or might happen.

In 46 cases the patients talked of plots and plottings, gangs, wars and revolutions; 19 patients believed that they were about to undergo, or had undergone, some form of physical torture; 18 patients believed they were about to be killed; 14 patients thought that their beloved ones or relatives were in danger; 12 that they were being, or were about to be poisoned; 9 that they had been robbed; 6 that they were about to be kidnapped or abducted; 9 felt themselves accused of immorality (these were all women); and 10 believed that their spouses or lovers had been unfaithful to them. Of these only three were alcoholic. This is perhaps of some interest in connexion

with speculations as to the psychopathology of jealousy ideas in alcoholism, which postulate a repressed homosexuality with subsequent projection. There was no confirmation in this small series of the thesis that alcoholic subjects were specially prone to infidelity ideas. Indeed there do not appear to be "control" cases on record as regards this point.

Turning from these bare lists and the tables (which have been omitted in this abstract) to the broader setting from which they had been wrenched, a few brief case-histories were given, in order to demonstrate how large a part the previous personality of the individual sufferer played in the delirious reaction produced. Difficulties in the assessment of "previous personality" were obviously great, in view of the important aspects so commonly present, yet not much in evidence in ordinary life.

Two of the patients had suffered from mental illnesses, not delirious in type (one manic, the other depressive), before their admission to hospital, and in both cases the delirious state was wholly in line with these previous illnesses—showing frank manic and depressive features respectively. In another case, in which a delirious state was superimposed upon a depressive illness, the patient retained the typical depressive self-reproachful ideas throughout her delirium. Another group of cases came under observation on more than one occasion, and whether the causative agent was the same or different upon successive admissions, the symptomatology bore the most striking resemblance. There was no case in which this was not true. A remarkable example was the case of a man with sudden heart failure who believed that his second wife was trying to poison his medicine. Thirty years previously, when suffering from a delirium of alcoholic origin, he had believed that his first wife was trying to poison him in a similar manner. He was known to have given up alcohol for eleven years.

Sometimes the relationship between previous personality and psychosis came out with striking force. The conditions for this appeared to be not only that should the previous personality have had well-marked characteristics, such as obsessional trends or egregious pomposity, but that the delirious disturbance should have been of relatively light intensity. If the depth of the disorder was too great, individual differences tended to become blurred, and the more general reaction tendencies of all human beings alone remained in evidence.

In brief, the reaction tended to become more comprehensible with knowledge of the previous personality as revealed by previous mental illnesses, individual characteristics, habits of reaction, dominant interests, past experiences, age, sex and intellectual endowments. As regards this last, it appeared that mentally defective patients showed, with abnormal frequency, a blind impulsive reaction to the environment, or complained of passivity feelings and the like, and in general showed symptoms of "schizophrenic" type, as also did the very youthful. This was in line with the well-known clinical pitfalls in the diagnosis of a schizophrenic illness, namely youth and mental defect (to which must be added a primitive cultural background).

Little was attempted as regards the description of the physical findings. It was, however, noteworthy how frequent was a temperature in the neighbourhood of 100°, when no obvious "cause" could be found (as in certain cases of bromide intoxication apparently free from respiratory or other infection). Neurologically, it was found that the abdominal reflexes were often found absent or diminished. Diplopia, oddly enough, was not recorded in alcoholic cases, but was found in several others.

Discussion.—From these records, no evidence was forthcoming that there was anything which could be regarded as specific for any ætiological agent, in the sense of the statement that "snake hallucinations spell the consumption of alcohol." From the literature it appears, however, to be true that with mescal, hashish, and perhaps cocaine, there is evidence in favour of a specific effect, and as might be expected this has been analysed as a rather general disturbance of function, of which the "snake-

alcohol" example would be a particular instance, for this general disturbance would also certainly manifest itself in other ways. For other agencies, the evidence in favour of a truly specific effect appeared to be meagre in the extreme.

The most that could be said here was that the delirious states appeared to be directly related to the ætiological agents, and could be considered characteristic of them, in the sense of a frequent statistical association of certain groups of symptoms, in so far as the ætiological agents tended to affect the intensity, duration, and stability of the functional disturbance in a fairly uniform manner. This would appear to be the most satisfactory way of classifying and describing delirious states. At present the textbooks do little more than ring the changes on delirious symptomatology, and it was hard to see why the reactions were described under so many headings. This was confusing to the student, who tended to deduce a specific effect from different agents, which very doubtfully existed.

The more acute and severe the delirious reaction, from whatever cause, the more did it tend towards either a dull semi-stuporose condition, or what might be called a more or less pure visual hallucinosis. In both these conditions, delusional ideas must necessarily be extremely fragmentary, for a certain preservation of the personality and a retention of the capacity to form more or less consecutive or related concepts, is clearly necessary for delusional formation of any connected character. As a corollary of this, an illness of longer duration, and a delirious disturbance of more shallow intensity, were found associated with any marked degree of systematization or persistent paranoid misinterpretation (as has often been described in pernicious anæmia). As regards the "stability," this appeared to be least in cases of drug intoxication, which were not so frequently associated with such general constitutional disturbance and a resultant condition of torpor, as occurred with certain other causes.

As regards an explanation of the frequency of the paranoid ideas, it seems that the type of disability found in delirious reactions is an excellent culture medium for their development, for it is comprehensible that if not merely a difficulty, but a difficulty which constantly varies, is experienced in a clear grasp of what is taking place, doubt and suspicion will arise. Paranoid ideas are not only evidence of functional disturbance, but in some measure are comprehensible reactions to it.

Even more than in the case of other psychiatric patients, it is most fallacious to consider the individual patient apart from the environment, for delirious patients respond to the stimuli received from the environment with abnormal facility and intensity, This not only has most important practical bearings from the point of view of nursing and management, but it shows up, as perhaps nothing else does, the nature of the disability from which these patients suffered, which appeared to centre round a decreased ability to discriminate and differentiate. They were worse in the dark; used shadows or indistinct sounds as the starting-point of illusional misinterpretations; were upset by the new, strange, changing, or complex; and were helped by the quiet, familiar, and simple.

It is evident that the personal contribution of the individual recipient to stimuli upon his sense-organs is as essential a part of a perceptual situation as the stimuli themselves. Without such personal contribution, the stimuli could not be recognized or possess meaning. In delirious reactions, the capacity to recognize sensory stimuli correctly, and relate them appropriately, was unimpaired. The personal contribution became unduly prominent, so that fears and expectations were readily confirmed. The resultant picture is perhaps most readily described by not only postulating a reduction of the "higher critical faculties," and with it a reduced capacity for sustained attention, but assuming an increase of the type of mental activity to which the nearest normal counterpart occurred in dreams.

The analogy between dream-life and delirious states is much closer than that between dream-life and schizophrenic states. This is as much a matter of subjective

experience as of objective description. In both visual imagery is strikingly in evidence, and in both individual preoccupations and conflicts are exposed freed from the usual restraining influence of probability and logic. Whereas in normal waking life the clear perception of outer reality checks the free play of fancy which obtains in sleep, in delirious states strips of a misapprehended outer world interrupted what would otherwise be ordinary dreaming, and disturb, distort or even occasionally destroy it. From this arose the perplexity, and with this, according to the individual temperament, reactions of fear, distrust and resentment.

Finally, as a result of the study of these essentially "physically" determined conditions, it became obvious that attention limited to the physical aspect alone would be very incomplete and indeed misleading. The study of just the same wide range of factors, constitutional, psychogenic (experiences) and environmental, is as necessary as in all other psychiatric cases. But they all showed in common "confusion"—a term the use of which should be limited to the description of the definitely organic reactions, or those functional conditions which closely simulated them. It should not be loosely applied to any case which did not respond briskly and appositely (such as "retarded" depressives, or many schizophrenic perplexities). It seems hard to believe that without evidence of this essential organic disability known as confusion, exogenous factors play more than a precipitating or facilitating role in psychoses, not therefore unimportant, but to be regarded as a factor, and not as the explanation or "cause."

Section of Surgery

SUB-SECTION OF PROCTOLOGY

President—W. Ernest Miles, F.R.C.S.

[*May* 16, 1934]

Cancer of the Colon: Its Surgical Treatment

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Modern surgical attack on colonic cancer is predicated upon physiologic and pathologic considerations; a logical conclusion when one considers that the colon is a dual organ both embryologically and functionally. As a result of differences in function, as well as in type of pathology, cancer of the right half of the colon is manifested by phenomena secondary to disturbances of physiological equilibrium, while cancer of the opposite side of the large bowel presents a syndrome of obstruction in one of its phases, chronic, subacute, or acute. Eliminating that group of cases presenting most often in growths of the left colon as acute intestinal obstruction, we may consider carcinomas of the colon, in the vast majority of instances, as chronic problems for the surgeon. This is a fortunate circumstance, because malignant neoplasms of the lower part of the gastro-intestinal tract occur most frequently in middle-aged individuals or in persons in advanced years, and, remaining unrecognized for a considerable number of months before they are accurately diagnosed, undermine vitality by a subtle progressive intoxication.

Preliminary preparatory measures prior to operation have been found to advantage these individuals enormously and I have no doubt that they are as important as either the operation itself or the after-care.

From a practical standpoint, one may consider the various offensives instituted for the surgical elimination of colonic cancer as divided into three phases: (1) Pre-operative, (2) operative, and (3) post-operative.

Pre-operative

Decompression is the most important fundamental principle of pre-operative preparation. Its accomplishment is essential, whether the cancer is situated in the right or in the left half of the colon, to overcome obstruction and to increase the individual's resistance for formidable operative procedures. Obstruction and ulceration increase enormously the permeability of the colon wall and when the lesion is situated in the right half, frequently produce a profound anæmia, dehydration, and desiccation in addition. Decompression may usually be accomplished within a period of from three days to one week, either by medical measures, which consist of frequent irrigations and mild purgations or, these failing, by surgical intervention.

One cannot urge too cogently the advantages gained during this period of preliminary decompression which rids the bowel of œdema and infection and more safely guarantees increasing the resistance of the patient to somewhere near normal. If one is unable by medical measures to accomplish a satisfactory decompression, then surgical deflation by ileostomy or cæcostomy is imperative. During this stage, likewise, rehabilitation is forwarded by feeding a diet high in calories and low in residue; carbohydrates are freely administered to build up a reserve of energy for the post-operative period, and fruit juices are used in as large quantities as possible. Blood transfusions have in my hands proved highly desirable, and I believe that their employment is indicated for other reasons than to combat anæmia. I employ them routinely after resection of the colon or rectum and before operation if the hæmoglobin estimate is low or the general condition of the patient sufficiently bad to grade 3 or 4 on a scale of 4.

In 1926, following some preliminary work by Hermann, I began using a vaccine of streptococci and colon bacilli administered intraperitoneally two days before operation. The vaccine hastens mobilization of the peritoneal defensive forces, and I feel that a series of cases extending to more than 1,000 has proved its usefulness as one of a number of steps to increase the individual's resistance to intraperitoneal infection and his ability to fight off peritonitis, which is the chief lethal factor following operation.

That the immunization by vaccination is a logical procedure seems unquestionable, yet a full knowledge of the exact reaction which each individual patient will have to vaccination is not available before its use and the subsequent exploration. It is possible that the reverse result of the one desired may occasionally take place and infection may result from the injection. I am uncertain in my own mind as to the exact value of this step, and yet I have the feeling that as one of a number of procedures aimed at rehabilitation it is of value. Were it necessary to abandon vaccination, decompression, or multiple graded procedures, or some of the other steps, I feel perhaps that this would be the first of the group to eliminate.

The Choice of Operation

While technical manœuvres in the two halves of the colon differ, it is my confirmed opinion that the principles of graded operation and of the radical extirpation of the gland-bearing tissues in juxtaposition to the growth, have been proved sufficiently desirable to be used except in unusual circumstances. One of the most advantageous steps in the routine removal of colonic cancers, in my experience, has been the utilization of as many operative steps as are necessary to avoid hospital mortality and at the same time ensure radical surgery. That a single-stage brilliant technical operation is desirable from the patient's standpoint and possibly from the surgeon's, cannot be gainsaid, yet radical surgery can unquestionably be applied routinely in a larger number of cases if it is done in multiple stages. These individuals are poor risks as compared to those who are subjected to surgery for many chronic ailments, such as cholecystitis, appendicitis, or pelvic disorders, etc., and when called upon to withstand a huge, and often tedious and shocking, resection, are advantaged, I feel, by the employment of several stages rather than one.

The first graded operation was carried out unintentionally by Schede in 1879 when he resected a segment of bowel and was unable to approximate the ends but brought them out of the wound as a double-barrelled colostomy. This principle of graded resection, plus exteriorization and decompression, was further popularized by Paul of Liverpool who utilized it first in a case operated upon in May 1892. This operation consisted of a primary resection of a left colonic growth and mesentery with decompression of the proximal loop by the insertion of a Paul tube. Further

experience has shown that this is a most satisfactory manœuvre, and to-day there is still a wide field of usefulness for it, especially where a preliminary decompression by medical measures has been accomplished. It may be modified by doing the obstructive resection complemented by a cæcostomy.

Bloch of Copenhagen in 1892 performed the first exteriorization operation without resection of the growth and added to it a decompressive colostomy. To the exteriorization procedure Hochenegg subsequently added a radical resection of the glands in the colonic mesentery.

From these procedures was born a second principle of huge importance in modern colonic surgery, namely, exteriorization. The result of the acceptance of the graded manœuvres and exteriorization operations, with or without complementary decompressive enterostomy, was an enormous reduction of mortality, which fell from around 50 per cent. to about 15 per cent. The logical conclusion to this is that the peri-colonic infection is a fertile field for the production of peritoneal contamination secondary to efforts at mobilization.

The present generation of surgeons has passed through many phases in accomplishing the establishment of these fundamental principles, but the fact remains that we have been largely interested in technical problems of resection, especially the attempted development of an ideal single-stage operation which removes the growth and at the same time restores the continuity of the gastro-intestinal tract. Experience now urges strongly that graded operations should be the routine, supplemented occasionally by single-stage resection when mature judgment and exceptional circumstances warrant, and that these primary suture operations, when employed, should be routinely complemented with a proximal deflation mechanism available if distension threatens the anastomosis.

In dealing with cancer of the right half of the colon, I believe the most desirable type of procedure is a two-stage method, the first stage of which is an aseptic end-to-side ileocolostomy between the transverse colon and the terminal ileum. Let me urge the end-to-side type of anastomosis, because only partial by-passing of the bowel current is accomplished by a lateral anastomosis. Side-tracking of the bowel content relieves the infection around the local growth and frequently results in an increased mobility to a fixed, or semi-fixed, lesion at the second stage. This second advantage increases the scope of operability and permits surgical removal of many border-line cases. I have often been agreeably surprised, upon removing a large questionably operable growth of the right colon at a second stage, to find no glandular involvement present and a low grade of malignancy. In the left half of the colon there are several types of manœuvres available, but to my mind in few of them is a primary resection and anastomosis indicated.

Distinctly do I hesitate to employ a primary suture in this half of the colon, because the presence of infection and obstruction increases the danger of failure of the suture line. It is my conviction that infection at the anastomosis line is responsible more often for leakage than is failure of the blood supply. Indeed, I am sure that the blood supply of the colon is quite adequate and uniform. Steward and I studied the vascularization of 100 colons and published the result in the *Archives of Surgery*, 1933, xxvi, 843, arriving at the conclusion that while there were certain variations in the arterial pattern, they occurred in a relatively small percentage of cases, and that many of the so-called failures of anastomosis due to poor circulation were more theoretical than actual.

My own choice of operation is an obstructive resection, which procedure employs the desirable feature of the exteriorization operation, and in addition, a removal of the mesentery and its glands. It is obvious that this operation is not applicable unless primary preparatory stages have accomplished complete decompression.

The technique of the operation is simple and consists in removal of the segment of bowel containing the growth, and the mesenteric glands, leaving the two ends of the bowel held in my clamp. Thus the bowel is completely obstructed for a period of from forty-eight to sixty hours. At the end of this time the proximal blade of the clamp is opened and the pent-up gases blow out the glued end of the proximal loop, decompressing the bowel.

In my experience it is especially advantageous to employ a complementary enterostomy in performing this operation where exploration indicates that all the evidences of obstruction have not completely disappeared. The introduction of a Pezzar catheter into the cæcum by Hendon's technique is an ideal type of procedure and if the tube is witzelized, one need not fear a subsequent persistent fæcal fistula. Also, I would emphasize the lack of necessity for suturing the bowel to the peritoneum which is wrapped snugly around it and which is strongly agglutinated at the end of forty-eight hours. I have never seen the proximal loop of bowel retract into the peritoneal cavity when the clamp is loosened, but I can conceive of it doing so when the rectal stump is short and under tension, and under such circumstances I would suture it snugly.

The subsequent stage of this operation is first to cut out the spur with an enterotome and hopefully expect a spontaneous closure. If the mucous membrane of the bowel lies below the skin margin and the spur is cut out deeply, closure without further operation usually results. If on exploration one finds that this type of operation is not available because of an obstruction which has not been relieved by the medical decompressive measures, cæcostomy may be performed and a resection of the same type carried out at a later stage. Occasionally one finds it is best to employ an exteriorization type of operation similar to that described as "the operation of Mikulicz," which in my experience, has a limited field of application. It cannot be employed in very obese people, or where the mesentery is very short, without sacrifice of the blood supply. When the blood supply is ligated and the bowel exteriorized, a foul, often gangrenous, tumour is found on opening the dressings at the end of forty-eight hours.

Three things frequently result from this combination of circumstances. First, wound infection ; second, peritonitis ; and third, transplantation of cancer cells into the wound surface. This last unfortunate complication occurs in 12% of the cases. Consequently, while I do not deprecate entirely this type of operation, I believe it should be applied as a procedure of choice in only well-selected cases. Some one of these operations has proved entirely satisfactory in my hands, either as described or with some modification, for the vast majority of cancers between the proximal end of the transverse colon and the juncture of the middle and lower thirds of the sigmoid flexure. There is a group—and it is not an especially small one—of cancers of the lower sigmoid which presents many additional difficulties of removal and for which no entirely satisfactory technique of extirpation has been developed. These malignancies situated distal to the top of the loop of the sigmoid, or two or three inches above the reflection of the peritoneum in the bottom of the pelvis, are with difficulty adjusted to any of the standard procedures.

One has a great desire, upon exploration, to attempt to save the sphincteric apparatus and restore the continuity of the gastro-intestinal tract. That this is an error in the majority of instances, I believe can be proved statistically by a study of end-results. Certainly, if metastases to regional glands have taken place before resection, any operation, short of a very radical combined abdomino-perineal resection leaving an inguinal stoma, is likely to be followed by recurrence. Again, the anatomical type of the individual will influence one's judgment and selection. I have frequently, in thin individuals, mobilized the entire rectum and brought the growth out, making an obstructive resection, and sacrificing the pelvic colon and its

mesentery. This obviously cannot be done in fat, muscular individuals, and I think that the choice of operation probably is a combined abdomino-perineal resection. The Hartmann type of operation, and the resection and anastomosis over a rubber tube have been advocated, but I have no enthusiasm for either. Occasionally one gets a brilliant result with a tube resection, but in reality it is a local resection without adequate gland removal, and I question whether it is applicable to a large number of cases.

Some years ago I performed a series of twenty-six anterior resections of low sigmoidal and rectosigmoidal growths—making a colostomy and turning in the rectal stump—with one death, or a mortality of 3·9%. This hospital death-rate was satisfactory and I should have continued this procedure except for finding two of these cases with a recurrence in the rectal stump within eighteen months after removal. Evidently cancer cells had been dislodged by manipulation and ingrafted on to the mucous membrane of the segment left behind. For this reason when I have utilized the anterior resection for growths in this section, I have subsequently at a later date taken out the short rectal stump, completing by a graded operation a combined abdomino-perineal resection. It is my conviction that the choice of operation here is a narrow one and that the combined abdomino-perineal resection should be the first selection, and obstructive resection, or anterior or tube resection, should be reserved for special cases.

If one insists on doing a primary resection and anastomosis in the left half of the colon, and by whatever type of technical procedure seems most desirable, one should, I feel, accompany this method by some decompressive manœuvre proximal to the suture line. For my own part, I prefer restraining my enthusiasm for complete operations in one stage and, disregarding economic factors, to remove cancers of the large bowel by multiple operations, with a lower operative mortality and with, I believe, more satisfactory end-results in a larger group of cases.

Post-operative Factors

Special supervision of this group of cases post-operatively is not merely desirable but essential. The prevention of peristaltic activity as nearly as possible is perhaps the most important immediate consideration after operation. Free use of morphine accomplishes this in part as well as relieves pain. Second in importance is withholding fluids by mouth for a post-operative period of forty-eight hours or longer. This period is variable and I have found it a good rule to begin giving fluids when the patient begins to pass gas from the bowel. Hydration is maintained by the intravenous or subcutaneous administration of from 3,000 to 4,000 c.c. of sodium chloride and 5 to 10 % glucose, under careful supervision.

Routine blood transfusions are administered on the day of operation. Complications are treated in a routine manner, except in the case of parotitis. This complication occurs seventeen times as often following operations on the larger bowel and rectum, as in ordinary surgical practice and is an unpleasant and serious affair best treated by radium applied over the swollen parotid regions as soon as evidence of enlargement is manifested. Our experience has proved that this method of treatment reduces the likelihood of having the gland suppurate and distinctly lowers the mortality rate of this complication.

In no other field of surgery is individualization of cases, pre-operatively and post-operatively, so essential. Careful attention to details after the operation is just as important a consideration as the proper selection of the operation for the patient.

PROGNOSIS

The hopeful prognosis following the successful surgical extirpation of carcinoma of the colon may be easily established by a statistical study of the end-results of a series of these cases. Last year in my Chairman's address before the Surgical Section of the American Medical Association, I reported a review of 453 cases whose length of life after surgery was known. It was interesting to note the various factors in this series which favourably or unfavourably influenced longevity. Age, co-existing debilitating diseases—such as diabetes and cardio-renal-vascular disease—and general debility were factors which could be estimated previous to operation and classed as extrinsic influences. Local influences found by exploration and modifying seriously the end-results, were metastasis to the liver or regional lymphatic glands, and local fixation of the growth, with or without penetration, to adjacent viscera, or abscess or fistula formation.

Age is an influencing factor in direct ratio to youth. Young individuals tolerate cancer, as is well known, much less favourably than the aged. Indeed, the study of a series of cases by Comfort and myself some years ago brought out forcibly the already well-known fact that in individuals 30 years of age and under, the prognosis in cases of cancer of the rectum was only half as favourable as in the average case, and metastasis had taken place in twice as many cases by the time exploration was performed. Furthermore, the grading of the growth was uniformly in the higher brackets.

Metastasis to regional lymphatics is a difficult factor to evaluate grossly, for the reason that one cannot estimate accurately by palpation whether or not glands in the vicinity of the growth are cancerous. They must be examined microscopically before such a diagnosis is arrived at.

Local fixation, attachment to adjacent viscera, and fistula-formation, influencing unfavourably the prognosis as they do, nevertheless do not necessarily rule out a palliative operation. I have several times removed the sigmoid and half of the bladder for a carcinoma, with the result that the patient has lived and performed his duties for a period of two years or more.

The most important factor which influences prognosis, in my opinion, is the intensity of the malignant-cells invasion, as estimated by Broder's system of grading. That this activity of the cancer-cells regulates the rapidity of dissemination and the consequent ultimate end-results is, I believe, an accurate statement.

In a series of 453 cases of cancer of the large bowel, studied by Olsen and myself, the percentage of glandular metastasis, and consequently hepatic implantation, was in direct ratio to the grade of the growth. For example, the nodal involvement in 187 cases of cancer of the right colon was 34%, and the average post-operative life of patients dying with recurrence was 15·7% months. While the average five-year cures of those right colonic cancers with the nodal involvement was estimated at 39%, in contradistinction to those in which there was no nodal involvement, the average post-operative length of life of patients dying with recurrence was 25·6% months, and the five-year cures were estimated at 66%, or two out of every three patients.

It was an interesting observation, but one which seems somewhat paradoxical, to find that in 266 cancers of the left colon, the nodal involvement was 31%, or slightly lower than that in cancer of the right colon. Because of the known differences of end-results in favour of the right half of the large bowel, one would readily expect a lower nodal involvement rate than in its fellow of the opposite side.

An average of the five-year cures of cancer of the right bowel with and without nodal involvement showed 57·6%, while the growths of the left half of the colon

showed a total of 51·3% of five-year cures. The importance of pathological types in any estimate of end-results following operation for cancer of the colon is obvious.

The vast majority of colonic growths may be classified in the lower grades (1 and 2). Approximately two-thirds of cancers of the right half of the colon fall into these groups, and three-fourths of the left half do likewise. This tendency to a low or medium activity is a satisfactory explanation of the well-known fact that these neoplasms remain local over a long period of time before distant metastasis takes place. This is in sharp contradistinction to the higher grades (3 and 4) which, while they occur seldom, metastasize rapidly and are of unfavourable prognosis. In youthful individuals, the higher grades are much more likely to be found and the prognosis is unfortunately in direct ratio. The grade of the growth should influence one not a little in attempting to extend the horizon of operability, it being justifiable, I believe, to attempt to remove border-line growths because of the possibility that they are of low grade and most often have not metastasized, their fixation being due largely to inflammatory reaction rather than malignant extension. This latter fact undoubtedly makes resection more hazardous, because of the likelihood of the necessary trauma incident to mobilization, but if measures may be applied to reduce this inflammation prior to resection, one may not only extend the limits of operability, but at the same time do so with a lower hospital mortality.

Operability is as important a consideration as is operative mortality. The tendency until recent years has been to attack only the more favourable cases surgically. By these I mean the cases in which the tumour is mobile and in which liver metastasis has not taken place. This, I believe, is too narrow a scope of operability and I urge a more flexible standard. No doubt there are few cases in which resection should be performed in the presence of hepatic implantations, but occasionally one is justified in undertaking the removal of a growth under such circumstances, because death from a liver metastasis is relatively painless, whereas a large ulcerating, obstructing, fungating cancer which has attached itself to an adjacent viscus, or invaded neurological elements, produces a most unhappy and distressing situation. After liver metastasis is ruled out, we should, I feel, make every effort to remove colonic malignancies, whether or not regional glands are found to be involved, if only the local fixation, either at primary exploration or after a side-tracking operation, permits us to undertake this removal, with an operative mortality which does not exceed 10%.

In my own experience, it has been possible to resect one out of two cancers of the colon as they present themselves and in occasional years it has been possible to extend this operability figure to two out of three. This has been accomplished with a mortality approximately 10% for all types of operation. Occasionally one may find a series of operations for cancer in either the right or the left half of the colon, in which the hospital mortality will be much lower; for instance, in the first series of obstructive resections which I carried out, 23 consecutive cases were operated upon before a hospital death occurred. Subsequently, with broadening of the scope of this operation, the mortality figure rose, but it has never risen above 6%.

In the opposite side of the colon during the past six years, I have used the aseptic end-to-side ileocolostomy between the terminal ileum and the transverse colon and followed it by a subsequent resection of the right arm of the colon at a later date, in 67 cases with four deaths—a mortality of 5·9%.

A special series of cases typifying a certain operation, however, is likely to prejudice one's mortality perspective, so that it is more equable to view the statistics for the entire organ. If this is done, and all types of operations and cases are taken

into consideration, I believe that one might be content with a mortality of about 10%. If this figure can be obtained with an accompanying operability of 50% to 65%, the margin of improvement will perhaps not be a very large one for some time to come.

It is my conviction, borne out by experience, that when the hospital casualty figure is reduced materially, the scope of operability likewise is contracted, and the result is that many patients with cancers of the larger bowel will, in consequence, be denied their rightful chance of life following surgical operation.

JOINT DISCUSSION No. 8

Section of Epidemiology and Section of Psychiatry

Chairman—J. D. ROLLESTON, M.D. (President of the Section of Epidemiology)

[*April* 27, 1934]

DISCUSSION ON THE VALUE OF THE TREATMENT OF MENTAL DEFICIENCY

Dr. F. C. Shrubsall: The terms of this question may be looked at from several different angles, and the answer arrived at may depend to some extent on the viewpoint chosen. Mental deficiency is itself rather a legal or social than, strictly speaking, a clinical term. Treatment covers more than medical or surgical measures, and must include the whole question of training and supervision for the encouragement of such abilities as exist and the stabilization of the character of the defective. Value may be considered from the standpoint of the individual sufferer; of the other members of his family who may find his presence in their midst a detriment or a burden; of the community at large, which desires to be rid of a nuisance; or of the local authority which has to pay some consideration to the relative cost of various methods of affording such relief.

The earlier enactments for the care of the mentally defective were unquestionably directed to the preservation of their property, and the law paid little heed to those who were not property-owners. The King had the care of defectives and their property, which he had to return to the heirs on the death of the defective. The Crown used to farm out the care and the usufruct, and courtiers used to ask for such cases, hence the phrase "to beg a fool"; after all, this constitutes an early form of guardianship. Later Acts were concerned with the care for the community, and the individual.

Early English law drew a sharp distinction between a failure of mental development and the aberration of the matured mind. Commentators on Plantagenet law defined the "natural fool" as "one that hath had no reason or understanding from his nativity and so is presumed never likely to attain to any," a view in perfect agreement with Esquirol, who in 1828 propounded a useful general definition of idiocy, a term which at that time covered all grades of mental defect. Esquirol put it:—

"Idiocy is a condition in which the intellectual faculties are never manifested or have never developed sufficiently to enable the idiot to acquire an amount of knowledge such as persons of his own age placed in similar circumstances with himself are capable of receiving. Idiocy commences with life or an age which precedes the development of the intellectual and affective faculties which are from the first what they are doomed to be during the whole period of existence."

The term "from birth or an early age" was incorporated in the definitions of the Mental Deficiency Act, 1913, and the bulk of the cases dealt with under its provisions belonged to types in which the condition was congenital or had been manifested in the first three or four years of life. A number, however, came to light in which there was a need for control on account of mental instability and arrest of mental growth at a somewhat later date; those due to attacks of polio-encephalitis or encephalitis lethargica attracting particular attention, especially when the conduct

of the sufferers led to the necessity of their being charged either in juvenile courts or courts of first instance. No consensus of magisterial opinion could be obtained as to the interpretation to be placed on the words "early age" which those who wished to obtain prolonged care and treatment other than of a penal, or quasi-penal, character desired to extend to the utmost.

The amending Mental Deficiency Act of 1927 introduced the definition:—

"'Mental defectiveness' means a condition of arrested or incomplete development of mind existing before the age of eighteen years, whether arising from inherent causes or induced by disease or injury."

This change regularized the admission to suitable certified institutions and the like of those suffering from the after-effects of sleepy sickness whose cases were exciting public sympathy and apprehension, but also opened the door for the admission of a range of young sufferers from organic psychoses.

Legal enactments and the provision of public care have been instituted under two separate influences. The one stressing the idea of training in the hope that the afflicted person may be enabled to remain in or return to community life started from the work of Itard and Seguin at the beginning of last century and led up to the Idiots Acts, the Education (Defective and Epileptic Children) Acts and certain provisions of the Mental Deficiency Acts. The second influence was the growing appreciation of the numbers of defective persons in the community who were a constant charge on public funds or charities and to some extent a menace to society so that some measure of care and control was needed for the protection of the community and for the care of the individual as well as to check the supposed prolific reproduction of the feeble-minded. Whereas in the former group of influences stress was placed on the question of educability, in the latter it was on serious social inefficiency. It is a little unfortunate that the term "mental defect" should appear both in the acts relating to education and in the acts relating to control. The social implications of the latter have certainly acted as a deterrent to the use of special schools which had shown their value both for the training of aptitudes and the stabilization of character.

As is indicated in the definition of mental defectiveness, mental incompleteness or early arrest may arise from inherent and often heritable causes or from some disease or injury during the pre- or post-natal life of the individual. These are often distinguished as primary and secondary amentia, respectively, the implication being that the one is heritable and the other not. It may at once be said that even though a secondary amentia may not be transmissible to offspring, the defective individual makes so unsatisfactory a spouse or parent that the mating of defectives should under all circumstances be discouraged. There is a greater proportion of examples of secondary amentia among low-grade than high-grade cases, and consequently a larger proportion of such cases will be found in institutions than among the population at large. Of 10,000 mentally defective individuals dealt with under the Mental Deficiency Acts in London and who were then placed in institutions or kept under supervision, 29% were suffering from secondary amentia, but it is generally estimated that the proportion among those who remain in the community is much lower. In this group treatment is often required for associated physical defect and serves to ameliorate their condition and at times to restore some degree of working capacity, though this can never be measured in terms applicable to a normal worker.

Statutorily, the mentally defective are classified into four grades, three of which (idiots, imbeciles and feeble-minded persons) represent degrees of social inefficiency, the fourth, moral defective persons, being perhaps high-grade variants of the third who show marked anti-social traits.

All can recognize the idiot: one who is unable to protect himself against ordinary physical dangers, who needs care throughout his life, can scarcely communicate with his fellows by speech and can barely find his way about the house, let alone the street. The imbecile is one incapable of managing himself or his affairs, or of being taught so to do in the earlier years of life, who requires supervision in personal hygiene and easily gets lost if he wanders beyond the confines of the street in which he lives. Though he can understand simple spoken language and may be taught simple routine tasks, he is unable to make the slightest adjustments to meet omissions or difficulties. A typical example is that of a boy who had washed a floor for years but was found one day lamenting that he was unable so to do. He had his pail, soap, swab and brush, but no water had been put in his pail, and he was unable to ascertain what he lacked. A feeble-minded person can acquire a little elementary reading and calculation and can learn a range of low-grade work, but cannot plan for himself or expend his earnings to advantage.

The investigation made by Dr. E. O. Lewis for the Wood Committee showed the relative proportions of these grades in the areas he visited to be idiots 4·1%, imbeciles 17·7%, feeble-minded 78·2%. (In this and in most similar returns any moral defectives would be included among the feeble-minded.) The proportions of the grades found in the first 10,000 cases ascertained in London under the Mental Deficiency Act were: idiots 5·3%, imbeciles 35·7%, feeble-minded 59%. This, of course, shows a lack of numbers at the higher end of the scale of intelligence which is accounted for by the fact that the Wood Committee endeavoured to ascertain the numbers of all defectives and that no administrative action followed their inquiries. A local authority is not required to ascertain all defectives, but only those "subject to be dealt with" under the Acts (other than at the instance of their parents or guardians), which means they deal only with those who have been caught in the education sieve or those who are in some way neglected, criminal or inebriate, or whose relatives have applied for help on their behalf. It is easy to realize that many cases brought to notice will be of the lower grades requiring assistance on account of their helplessness and inefficiency, or higher-grade cases who are a nuisance or menace to their relatives and the community on account of instability or anti-social behaviour, so that an undue proportion would be expected to be cases of secondary amentia.

The question what is the total number of mentally defectives in the community is not easily answered. The Wood Committee estimated that there must be some 300,000 persons who were mentally defective, in the social sense, in England and Wales, or 8 per 1,000 of the population, and in addition some 35,000 children who needed to be educated in special schools and who might be described as being mentally defective in the educational rather than the social sense. If the social and educational treatment of the mentally defective is to be of value, it is of the utmost importance that the fullest information as to the numbers and whereabouts of the affected individuals should be in the possession of the local authorities (the councils of counties and county boroughs) concerned with the administration of the enabling Acts. In other words the process of ascertainment should be as complete as possible.

The relationship between estimates and the information at the disposal of the local authority may be illustrated by the case of London. At the census of 1931 the population was 4,397,003, or roughly 4,400,000. On the estimate of 8 per 1,000 based on an average of six areas there should be 35,200 mentally defective persons in London. If, however, the comparison be made with the extra-metropolitan area investigated by the Wood Committee and the rate (5·71 per thousand) found therein be applied, there would be an expectation of only 25,200 mentally defective persons in London.

At the end of 1933 London was dealing in round numbers with some 20,000 cases and had a knowledge of some 11,000 others.

(1) Under some form of institutional care	12,000
(2) Under guardianship, supervision or after-care ...	4,000
(3) Attending schools	4,500
(4) Special school leavers whose period of after-care has expired, but whose record is available, at least ...	11,000

The total lies between the two estimates of the Wood Committee and would seem to indicate their substantial accuracy.

Mental deficiency is a permanent condition, and failing satisfactory home circumstances it must be expected that institutional care will ultimately be needed in all cases. Of those under supervision a number each year have to receive institutional care as their parents die or become unable to make the necessary home provision. It is, however, necessary to bear in mind that these persons would in any case need some form of public assistance of a residential character, so that the comparison is not between providing institutions and providing nothing, but between certified institutions and public assistance institutions. Many of the defectives are infirm, others have habits or traits of conduct which would render their care in the ordinary public assistance institutions difficult and more expensive than the average. The cost in different certified institutions naturally varies according to the age or helplessness of the patients, the amount of medical and nursing care required on the one hand or the amount of training given on the other.

It would, perhaps, be difficult to state which of the various activities comprised under the head of institutional treatment is of the greatest value to the community as a whole, but there can be little doubt that the prolonged or permanent care of low-grade cases and of those of higher mentality who are incapacitated by concomitant physical defects or ailments, paralysis, defective vision or hearing, epileptic fits, incontinence, and the like, is greatly appreciated by the majority of friends and relatives, as also, within the limits of their mental capacity, by the patients themselves. Such patients require much nursing service and are often largely, or even entirely, cot and chair cases. A larger staff is thus needed not only for nursing but to carry out routine duties, which in wards or institutions catering for those of a higher grade might be performed by the patients themselves. Although the weekly cost of institutions for low-grade and infirm cases and for low-grade children is necessarily greater than for those dealing with higher-grade patients and is some five shillings to ten shillings a week above the basic cost of general public assistance institutions, it differs but little from that of institutions catering for sane epileptics, many of whom are physically fit to render routine help for a large part of their stay, and is less, very considerably, than that of hospitals dealing largely with chronic cases. It is a great boon to such sufferers to be kept with their like to avoid the inevitable contrast with the normal or relatively normal that would occur had all been left in public assistance institutions, while so far as the physically defective crippled and infirm are concerned, if they were concentrated in special wards of a public assistance institution, the extra nursing care required would raise the costs of the institution. Many, too, if not in certified institutions, would have to remain in the hospitals for the chronic sick and infirm, where their habits and incapacities would be in considerable measure a nuisance to their fellow-patients and the staff.

In institutions for those of higher mentality and relatively normal physique occupation is necessary to secure contentment and happiness as well as for therapeutic or educational reasons. There are many of the mentally defective who can be trained to carry out routine tasks, sometimes even tasks of some complexity, provided there is someone at hand to deal with unexpected situations or emergencies. Such are better employed, and by their labour can contribute to some extent to the

cost of their maintenance, but they are unable to compete in the open market, owing largely to inability to detect any change in the circumstances of their employment, adjust any minor defects in apparatus they may employ, or adapt its use to slight variation in circumstances. The main use of the institution in their case is that it offers them a safe asylum, in the older sense of the word, and by segregation protects the community, not only against any acts of folly, misdemeanour, or even crime, which they might commit, but acts as a preventive against the propagation of their species. Whatever be the grade of their offspring, the defective are always unsatisfactory parents. The cost of institutions for such defectives is little above that of an ordinary public assistance institution, the difference being due in part to the cost of training and in part to the extra supervision required. The patients left in ordinary institutions from which they could periodically take their discharge would be a frequent nuisance to the community and might well have undesirable offspring. A certain number of patients of the higher grades of mentality with more emotional control are found, after training, to have acquired sufficient aptitudes and a sufficiently stabilized character to be restored to life in the community. Such restoration—at first, at least, and perhaps for considerable periods—takes the form of absence on licence with a view to subsequent discharge if all circumstances prove satisfactory. The number on licence from an institution depends to some extent on the training facilities available, but mainly on the mental grade of the patients. In January 1934, the number on licence from all the mental deficiency institutions under the management of London County Council amounted to 6·6% of the patients detained in the terms of orders under the Mental Deficiency Acts, but this includes institutions of all kinds and covers defectives of all grades of mentality. Taking the chief certified institution at which training is carried out, the number on licence amounts to 11·7% of the number on the books and at one of the smaller homes devoted to those of higher grade though unstable in social conduct the proportion on licence rises to 26·3%. This means that there is a definite flow of persons restored to community life so that for the additional expenditure of some three shillings to six shillings weekly over the basic rate in the public assistance institutions the community may be said to receive a substantial dividend. A careful watch is kept on those on licence so that if difficulties arise they may be recalled to the institution. The necessity for such action is relatively rare, though when it is required the case at times attains an undue publicity. Some 55-60% of those on licence are wage earning and most of the others are assisting relatives or friends.

Guardianship is most largely used as a means of aiding those who are suitable to be left in their homes provided some financial aid can be given to the family, and at the same time of securing a somewhat closer degree of control in the form of regular visits both by medical and lay inspectors than would be available if the family had been financed solely by way of "out-relief" through public assistance sources. A certain number of individuals are suited for placing with paid guardians in, usually, country districts where they can find some occupation and can at times help to support themselves by earnings. The usual rate of assistance to one in his home in London is from ten shillings to fifteen shillings a week.

Supervision—which consists of visits at regular intervals, varying from monthly to annually, as may be prescribed—serves to help the families and to keep in touch with the defective, so that if further help or closer care becomes necessary it can be afforded speedily. The younger persons under supervision are helped to obtain employment, and in all cases the family are advised as to measures for care and protection. Supervision shows the subject that his condition is noted and that help will be given if required but in no way interferes with his normal mode of life.

On the educational side the results are even better owing to the somewhat higher mentality of the subjects. Idiots and imbeciles on the one hand and the merely dull or backward on the other are not admitted to special schools. At the special

schools which have small classes, attention is paid to character, development, and stabilization through the personal influence of the teachers who are most devoted to their charges; and to trade training. As a result it is a common experience that those of higher grade who have passed through a special school can, on attaining the leaving age, secure posts more readily and at a higher rate of pay than those from the lower forms of the ordinary elementary schools. In London the school attendance lasts until 16 +, and before leaving, the case of each pupil is considered from the aspects of social behaviour and prospective earning capacity; those who are deemed to need further aid in the form of supervision or institutional care are notified by the Education Committee to the Mental Deficiency Authority, the Mental Hospitals Committee of the Council; the others receive two years' after-care and placement through a special employment bureau conducted by the supervision section of the mental hospitals department in conjunction with the Board of Trade. At the end of 1932 out of 761 pupils between the ages of 16 and 18 who had left special (M.D.) schools and were receiving after-care 634 were employed, 82 were judged to be employable but were actually out of work. This is a not unsatisfactory proportion considering the general industrial depression and indicates the value both of the school training and the placing bureaux. The heads of some individual schools can show figures for the after-histories of their pupils over considerable periods. In one school records over a period of fourteen years showed that of ex-pupils in that time $2\frac{1}{2}\%$ had died, 4% were incapable of work, 86% were employable and 82% actually employed.

It is often alleged that all mentally defective persons are prospective criminals. The after-careers of the pupils of the London special schools on the other hand show very definitely the stabilizing effects of education. In two years (1932 and 1933) 168 mentally defective adults were brought to notice through police court action; of these, 65 had attended special schools either in London or the provinces and a considerable proportion were from the provinces, which—considering that there are annually over 700 such leavers from M.D. schools in London alone, and that a few years back with a larger population the numbers were even greater—is not an alarming proportion.

Another fear that is expressed with regard to allowing defectives, even if of high grade—or perhaps even because of high grade—to remain in the community is that they may produce numbers of defective children. The recent report of the Brock Committee states that " the supposed abnormal fertility of defectives is, in our view, largely mythical." The inquiries set on foot by that Committee led to reports on 3,733 defective parents who had produced 8,841 children of whom 2,001, or 22·5%, had died, which, as the Committee points out, confirms the conclusion drawn from other evidence that the mortality among defectives and the offspring of defective stocks is abnormally high. The Committee report that where one parent is defective 16·9% of their children between the ages of 7 and 14 are mentally defective and 23·5% retarded, while of those over 14, 32·4% are mentally defective and 13% retarded. On the average, however, the children are of better mentality than their defective parent. Data collected in London for submission to the Brock Committee give some clue to the correlation between parents and children. Using as a measure the intelligence quotient (I.Q.) which consists of the mental age as estimated from tests of the Binet-Simon pattern divided by the actual age of 14, whichever be the smaller number, the following figures emerged:—

INTELLIGENCE OF CHILDREN ONE OF WHOSE PARENTS HAD BEEN DEALT WITH UNDER THE MENTAL DEFICIENCY ACTS

Defective parent	No.	Average I.Q.	No. of children examined	Average I.Q. of children
Father	36	63·0	62	87·2
Married mother	88	61·0	133	85·5
Unmarried mother	150	59·5	169	78·8

The average intelligence of the children thus varied on the average with that of the affected parent though the correlation is slight; unfortunately the mental age of the other parent was not known. It must be noted that the average intelligence of the defective fathers is greater than that of the mothers.

This may be due to the fact that it is only the better grade of defective men who can find a woman willing to enter into the state of matrimony with them.

The Brock Committee point out that whereas the marriage rate of defectives is lower than that of the normal population, the illegitimate birth-rate is higher. The rate, however, in those who have been "under supervision" seems to be definitely lower, showing the advantage of a procedure for keeping touch so that institutional care can be provided on the occurrence of any strong suspicion of moral danger.

Of actual medical or surgical treatment there is little to be said. At one time it was hoped that craniectomy might assist the development of the brain by relieving pressure, but it proved a failure. The most successful element is the treatment of syphilis at an early age, which does something to reduce the number who develop specific encephalitides in later childhood; a few cretins are benefited by thyroid treatment but their number in any case is small, and usually by the time the case comes to the notice of a deficiency or education authority the time for effective glandular treatment in the hope of preventing mental arrest has passed.

The effect of the Mental Deficiency Acts and Section 55 of the Education Act may be compared to a filter which, by removing insoluble residues, enables the social machine to function more smoothly. Defective children in a large class either hold back the others or simply are left to stagnate and do nothing. In special classes with appropriate curricula they can be brought along definitely, though it may be at less than half the normal rate and, as shown above, many are stabilized and made wage earners. The present-day ideas of the care of juvenile and young delinquents turn round the use of probation, but a probation officer who is saddled with a group of mentally defectives can neither place them properly nor devote the necessary time to his other charges. Many petty offences are due to stupid—rather than to deliberately anti-social—acts on the part of those of defective mentality. Stabilization and restoration is possible for many, but not under the condition of ordinary approved schools or even of Borstal institutions; more special treatment is needed.

The public hospitals are relieved of those who are not only unable to do much for themselves, but who by their habits make ward routine and cleanliness more difficult, and who by their lack of appreciation or memory for instructions may actually serve to spread infection.

Lastly, segregation is a great relief to the families and relatives of defectives and tends to limit procreation, though this is the weakest of the arguments for its use. Taking all in all, the public does get a return for its expenditure, and, as a former Medical Officer for Nottingham said, "It is wise economy to spend more to waste less."

Dr. Rees Thomas: The value of treatment is calculated in terms of the object in view and, until we are able to define our attitude to the problem of mental deficiency, it will not be possible to estimate the degree of success or failure attending the measures we are taking to train and protect those of a lower level of intelligence. As individuals we may have solutions ready to hand, remedies more suitable perhaps to discussion than to practical application, and more easily talked about than judged in the glaring sunlight of scientific basis and probable result. At this meeting I feel that we must not attempt to discuss any possible method of eliminating mental deficiency. This highly desirable effect is outside the range of practical policy. The recent report of the Sterilization Committee has indicated a direction in which we may travel, but, while this is interesting, it cannot well be brought under discussion

as having practical result and proved value; the problem is, however, receiving much attention and research continues.

If we cannot eradicate mental deficiency, what is to be our aim? If we talk of the value of the treatment of a defective from the purely medical aspect, we have comparatively little to say about it. Cretinism toes the line with the marvellous successes and unexplained failures of treatment by thyroid extract. We have cured some cases of epilepsy, or perhaps it would be truer to say that Nature, in some marvellous fashion and in a way as yet unknown to us, has cured them for us. We can relieve a defective's headaches just as we can cure the headaches of any other patient, but we cannot make his head swell, except with pride. We have talked a great deal about heredity and from time to time we have discussed it with much feeling, but Mendel gave us more precise knowledge of the form and colour of peas than we have since been able to learn of the tempers of man. Duplex and simplex minds, general intelligence G., and special factors are merely the small guns playing on the fortress. The results of our studies on heredity have been set out in the report of the Committee on Sterilization to which I have referred, and from this we learn how little progress we have made in our researches into the definite causes of mental defect. It is an interesting point that it may be almost as important socially to prevent the defective from having charge of a family as to exclude her from bearing children. Again we are in some difficulty in our search for knowledge. We have discovered that we do not know what environment in relation to the mind really is, in the sense that we know how to create the proper impression, the controlled restraint, the degree of emotionalism, the extent of extraversion or introversion necessary to make the child into the dominant yet humble man who is sufficiently pliant to seize every opportunity and to bend happily before every storm.

In estimating the value of other forms of treatment, however, we are on surer ground. Mental defect, as I see it, is a social defect, and if we can treat patients so as to enable them to carry on an independent social existence, we can claim this as a success. I think it would be true to say that in this sense there are a very great number of cures.

I will now refer to some of the various preventive and palliative measures that have been adopted here in this country under the Mental Deficiency Acts, 1913 to 1927. The methods of social treatment and training may be referred to under the headings of voluntary supervision, statutory supervision, guardianship, leave of absence, institutional care, home training, occupation centres, industrial centres, and school and occupational treatment in institutions. The first step in the approach to the problem of mental deficiency is to ascertain the number of defectives in the country and of these the proportion requiring the various forms of care, supervision, and control. The work of ascertainment and treatment is carried on by the Local Authorities assisted by voluntary associations. There are two State Institutions for children and adult defectives of dangerous and violent propensities.

Institutional treatment.—The institution may be regarded as the training centre for those who are unfit to live in the community, and though a great many never reach a high standard of conduct and achievement, the success of the training methods adopted may be judged by the fact that large numbers return from the institutions to resume, under proper care and safeguard, family and community life. It is obvious to those who are connected with the work, but not always so clear to others, that the defectives who are retained in institutions are those who must be there because they need the care, training, and supervision they cannot get elsewhere, or because they are a danger to society. It does not follow that the great majority of the medium- and high-grade patients need permanent segregation. But they do need—particularly during the childhood and adolescence stages—such training and control as we all need to bring out the best in us. It would be as absurd to take patients into an institution and not train them to the limit of their capacity as to

refuse to educate a proportion of our normal children because we know they are to remain through a part of their lives totally unemployed. One of the most important functions of the institution is to train the patient in order to make him wholly or partly self-supporting, and if there is any chance that he may become this he must be given an opportunity to make, like others, normal adjustments under ordinary social conditions. In making provision for the treatment of the defective, Parliament has not laid it down and, so far as I am aware, the medical profession have not attempted to press the view, that because a person is defective he should be segregated from his fellow men. The principle is, rather, that if he can keep himself, and if he does not offend society, he should be free. Against this we put the point that he must not be allowed to suffer too much in the process. The maintenance of patients in institutions is a costly business, and though it may be justified where the patients can be returned to ordinary society, some people may question the advisability of training where there is no hope of this kind of success. I cannot agree that mere isolation and handling, without any form of training and without the gift of some, at least, of the amenities of life, is a possible solution to-day; that must remain a memory of the Middle Ages of mental deficiency practice—even now only thirty years distant. It would be a great mistake to care for defectives in such a way that parents should be unwilling to accept the conditions under which they are treated. Life in a colony is practically a complete society, and the members occupying it must, for the happiness of the remainder, behave up to their capacity. This is true both of the nurse and the patient. Occupation forms an essential part of the life of the defective living inside the colony, and if he can be made partially self-supporting in this limited circle, his usefulness will bring happiness to himself and some measure of financial relief to those responsible for his care and maintenance.

There is an excellent method of deciding the ability of patients to live away from institutions in the community. I refer to leave of absence on licence. It has the advantage that patients can be tried under other conditions outside the institution, and that they may in case of failure at once run back to the shelter of the colony without formality or further certification. If they succeed they can remain under other forms of extra-institutional care, the most important of which is *guardianship*. Under the system of guardianship the defective is treated in the family circle either with his own people, or, more frequently, with adopted guardians. In suitable cases this means of care has the happiest results. The patients settle down to home life, and, as the Local Authority, through its own visitors, sees the patient at intervals, difficulties on either side are readily overcome. Whenever guardianship has been a failure it has been because the patient is unfit for this mode of treatment or because, from lack of experience in making selection, the guardian has not been a suitable one. Sometimes, owing to the scarcity of beds available in colonies, obviously unsuitable patients have been put under guardianship, with unfortunate results.

Other defectives who have been found subject to be dealt with under the Mental Deficiency Acts are kept under *statutory supervision*. They usually live in their own homes and the parents are given every assistance by the Local Authority. By this means many patients are able to stay at home and, on a reduced scale, to live happy and useful lives. The great advantage of supervision is that the Mental Health Visitor is able to suggest, and to bring into effect, a change of treatment and residence when this becomes necessary.

By *voluntary supervision* we mean that the defectives are visited in their homes, with the consent and approval of the relatives and, while these visits are not compulsory ones, it is clear that they may be extremely helpful both to the parents and to the patient.

I must say a word about the various methods of training and occupation provided for patients living outside institutions. A method recently adopted and extended

by the voluntary associations is *home training*. Many mothers find it extraordinarily difficult to manage their defective children at home simply because they do not know what to do with them. A visitor who can teach them the elements of training, and even provide some of the material, must earn the gratitude of mothers who have been anxious to undertake the care of their own children.

In centres where the requisite number of ineducable children can be collected, day training is afforded them in Occupation Centres. *Industrial Centres* are intended for the continued training of those over 16 or for the occupation of older defectives who are unable to find any work or for whom some sort of active occupational treatment is necessary to keep them out of mischief. In a few areas there are clubs and evening classes, but these can only exist in large centres or where defectives under supervision are grouped in particular areas. Naturally, only the smallest proportion of defectives living outside institutions are able to avail themselves of these amenities. There are in this country at the present moment 154 Occupation Centres, 22 Industrial Centres and about 10 Clubs and evening classes.

An important point to consider in our estimate of the value of treatment of deficiency is the proportion of defectives who actually come under any form of care-training and supervision. At the beginning of this year the number of defectives reported to the Mental Deficiency Authorities, whether subject to be dealt with or not, was, in round figures, 106,500—equivalent to 2·65 per thousand of the population. The expected proportion for all areas, according to Dr. Lewis's report, is 4·52 per thousand. This, of course, is exclusive of the children, rated at 2·82 per thousand, who are educationally defective and, between the ages of 7 and 16, are mostly dealt with by the Local Education Authorities. The defectives who have been ascertained are distributed in institutions (35,794), under guardianship, or notified cases (3,049), under statutory supervision (31,921); the remainder are under voluntary supervision. It may be of interest to note that it is considered that approximately two per thousand of the population will be defectives who require institutional treatment. This proportion has been reached in some areas.

This then is a short account of what we are doing for the defective in this country. The process of ascertainment is going on and the means available for treatment are steadily increasing year by year. I believe that in the present circumstances we should regard our methods of dealing with defectives as a compliment to our good sense and medical instinct. Expressions of failure form a large part of the vocabulary of the defective who is living under unsuitable conditions and so long as he remains unsupervised and lacks the care he needs his behaviour may so deteriorate as to be a menace to society both directly and through infected normal boy and girl adolescents. Because we cannot yet solve the problem of the defective, we are not free from the necessity of attacking it in whatever way we know. Something in our civilization prevents us from any longer enjoying the misery and loneliness of the village idiot, but we should be clear that our means of care and training are experimental and that we are treating symptoms because as yet we cannot deal with the cause. We may console ourselves with the thought that if the discovery of every new dish is of more benefit to humanity than the discovery of a star, we need hardly fear that the progress of man depends entirely on the inheriance of a higher intelligence. A chance combination of ingredients may be found to produce the same desirable end of normality by the more agreeable appeal to our palates. Thus the combined influence of heredity and environment may prove to be more important than either factor, taken without the other, in the making or marring of our minds.

Dr. Noel H. M. Burke: In all discussions on mental deficiency there is an unfortunate tendency to generalization and simplification which is not justifiable. It is necessary that on all these occasions the point should be emphasized, and borne in mind throughout, that mental deficiency is not in any way a disease entity but is

a symptom or state occurring, in several different forms, in many entirely different conditions.

We have to consider not only degrees of deficiency, and primary and secondary classifications, but all sorts of distinct conditions with different causations, showing different qualities and temperaments and involving different handicaps and different needs. The deficiency of the paralytic type is very different from that of the mongol, who differs from the microcephalic and he from the cretin, and so on throughout the series. And within each group there is diversity again and not uniformity of pattern in the deficiency.

I should have been better pleased if the title of this discussion had referred, not to "the treatment of mental deficiency" but to "the treatment of patients with mental deficiency," and it is from that aspect that I shall contribute to the discussion by considering the personal value of treatment to individual defectives.

Many patients of the medium and higher grades suffer from the feelings of the outcast and the inferior when exposed to the competition of the normal world. They feel this whether in school, in their own homes or in employment. Other people are not always kind to them or considerate, and they feel their inability to keep pace with their superiors.

The provision of a modified and specialized environment, built to suit the defective, relieves him of this painful kind of situation, enables him to compete on level terms with his neighbours and with the demands of life in general and, by so much, makes him happy. This end is achieved in various ways, whether by the special school or occupation-centre or by the more thorough change to life in a specially adapted institution.

Here one may mention the case in which the patient is not directly touched at all, but treatment, in the form of explanation and advice, is given to the parents. It is not uncommon for parents, with every good intention, to apply to their defective child a continual drive and pressure in the effort to procure normal standards of attainment from one who cannot possibly attain to such standards. This is an unconscious form of cruelty which can be remedied, to the greater happiness of the individual patient.

Some defectives suffer from specialized physical handicaps as well as from the lack of intelligence. If one can put these people in the way of some achievement—some visibly successful performance—one can make them happy and self-respecting. This applies to most defectives but particularly to those with the double handicap. I have brought here, for your inspection, illustrations of what can be done. There are examples of handwork done by a chair-ridden man with paralysed legs, a woman with only one hand, a boy and a girl with paresis and athetosis.

On the more general point of achievement, I also show two examples of needlework done by feeble-minded girls. These are easily portable illustrations of the effect of treatment and of the value to the patients themselves. The other examples are not transportable and consist of the other activities, occupations and useful performances in many phases of the general life of the defectives.

Turning to difficulties of temperament and character, such as concern reasonableness, self-control, trustworthiness, and honesty, much can be done by wise and careful general handling. Much can be done by the specialized methods of Guiding and Scouting which teach standards of duty, control, and trust. But I am concerned here to emphasize, not the value of treatment in restoring the patient to usefulness and even to the community, but the value to the patient himself.

A girl, previously in a closed ward and under careful supervision, was sent on a message to another part of the colony. She was obviously surprised. "Am I to go alone?" she said. "Of course; you'll be all right." Her pleasure and pride in this sign of promotion to a state of independence and trust was, I submit, a valuable part of the results of treatment in her case.

There is also a negative side to our subject. There are the instances where wrong treatment has been applied and the results are not valuable to the individual, but detrimental. There are two such groups to which I want to refer, though my views may be regarded as controversial.

I have seen several young adults, only slightly defective on intellectual standards who, because of behaviour problems in their boyhood, were certified and sent to institutions for defectives. I have felt that they were wrongly treated and were spoiled by such handling and that, were such cases seen to-day, they should be given the full benefit of the efforts of a child-guidance clinic before any decision is made to treat them as defectives. They are sufficiently intelligent and sensitive to suffer from the peculiar personal difficulties that are dealt with by such clinics and to respond to their methods. In an institution such a person may learn, from other patients, much that is most harmful.

My second point is that there is a definitely adverse effect on many defectives if they are subjected to treatment in the environment of a mental hospital instead of in that of a mental deficiency institution. It is not anybody's fault; if I were running a mental hospital I should get the same results. For want of other accommodation many defectives have had to be so dealt with in the past and mental hospitals must order their affairs to suit the needs of mentally disordered people. From experience, however, I have formed the opinion that this is not the proper setting for the mentally incomplete and that it produces what we are beginning to call the "mental hospital type"! There is, on top of the deficiency, a kind of superadded layer of dullness, lethargy, inability to respond, a daftness and a general lowering of quality which is similar to what is seen in some patients who come for the first time for treatment straight from their homes.

These are my two examples of the negative value of unsuitable treatment.

Dr. Ralph P. Williams said that a good example of the value of treatment was to be seen at Exeter where a house had been provided for feeble-minded girls who were formerly inmates of the Royal Western Counties Institution at Star Cross, and who were considered sufficiently stable to live in the city and to go out as "daily helps." They thus had supervision at night and if any were found unsuitable for this domestic work they could be readmitted to the institution.

It was known that mental defectives often did monotonous work better than those possessing normal intelligence. The head teacher of a special school for defectives in Bermondsey found that near the school was a factory where girls were employed in packing chocolates. She therefore taught the elder mentally defective girls to pack sand in paper as neatly and expeditiously as possible, with the result that many of them were taken on at the factory when they left the school, obtaining the work in competition with girls from the normal schools. It was reported that the girls from the school for defectives packed well, and as the result of their training in school they could do the work at once and did not require the week's tuition which was necessary for the normal girls. It may be remembered that after the War, when many workers were discharged from factories, mental defectives were sometimes retained, as it was found that they did monotonous work better than normal people, and moreover did not periodically ask for an increase in their wages.

Years ago, when a Medical Officer at Broadmoor, he (the speaker) had met with certain feeble-minded persons who had committed serious crimes: under the régime of the asylum they were satisfactory and well-behaved persons, with no tendency to relapse. Looking back on his experience, of which he gave some striking examples, he felt that the amount of crime prevented by institutional care was well worth the money and trouble expended upon it.

As to treatment of syphilis, he knew of one Authority by which active measures had been taken. Every child in the school for mentally defective children was examined by the V.D. Medical Officer, and those with a positive Wassermann reaction were treated, and in some cases benefit was demonstrated.

Whenever he was in an area where occupation centres had been established under the Local Control Authority, he visited them, and he had been favourably impressed by the work that they did for the unfortunate children of a grade lower than those taught in special schools; the work was very encouraging and the happiness of the children was certainly increased as a result.

Dr. Letitia Fairfield said that Dr. Burke's criticism of the title of the discussion—i.e. that it did not express sufficient regard for individual defectives—had been well met by his own paper, in which he had shown what could be done by individual care and training of defectives. In taking that line, however, he had adopted a very unfashionable point of view. The small size of this audience, representing two Sections of the Society, as compared with that at a meeting which considered sterilization of defectives, or at a recent meeting dealing with a sex question, showed that the point of view which considered defectives as fellow human beings whose difficulties had to be tackled and whom the profession had an obligation to help was quite out of date in the medical profession and the country at large. Had to-night's subject been the treatment of mental defectives, and not the treatment of mental deficiency, she thought the audience would have been smaller still. And the deficiency in a due understanding of this subject applied to high quarters too. Until more encouragement was forthcoming from the Board of Education the question of the training of defectives would, she felt sure, be gravely prejudiced. At present the building of special schools and the training of these children was held up. If the public realized the state of the matter, she believed that this stagnation would cease.

The value of the ascertainment and training of defectives was made clear by Dr. Shrubsall's figures. She would like to add one other figure in confirmation of what Dr. Shrubsall said, namely, that concerning the untrained defective who had not been in a special school and who formed the criminal to whom so much attention had been drawn, and from whose numbers such false deductions were being made. In London many workers had done their best to deal with defectives, and, after all the talk about this menace to the community, it was found that the number of defective criminals who were ex-special school children discovered in London every year scarcely amounted to one busy morning's work in one police court. The casual wards in London had been "combed" for defectives for three years, and routine examinations were carried out by an expert officer. Last year, as a result of these examinations, two mental defectives were discovered. They were, of course, more frequent in rural areas.

She wished to insist that this problem of the training of the defectives in the community was a permanent one, for, however drastically the attempt was made to deal with fellow citizens taking the social test of mental deficiency, there would always be 10% of a lower stratum. Unless all were going to be bred completely to type, there would always be some persons at the lower end of the scale, there would always be individuals who tended to come upon others for their support, who fell out of employment, who were exploited by the more intelligent members of the community. The subject was not one which could be settled by a pseudo-scientific smattering of applied biology, and for that reason she considered that the papers read in this discussion had been some of the most important to which the members of the Sections had ever listened.

Dr. G. de M. Rudolf: The subject of the treatment of mental deficiency is a large one, but I propose to deal with only one aspect, namely, behaviour of male adult mental defectives of all grades. The observations have been made at Brentry Colony.

Radical changes in the administration of this colony have been made in the past few years, so that there are periods before and during these changes which are comparable. In 1930, the head male nurse, Mr. Muschialli, originated a system of behaviour records. By means of these records it is possible to collect every item of misbehaviour or mental abnormality occurring in any patient during each year since 1929. The records deal even with minor matters, such as insolence to the staff, bad language, being out of bed at night, etc., but for our purpose only the more serious items, those of assault, theft, destructiveness, and cruelty will be dealt with.

To determine whether improvements are occurring in the behaviour of individuals, patients who misbehaved in 1930 and who are still at the colony were followed year by year in the records. In 1930, 45 misbehaved on 76 occasions, whereas the mean annual number of these who misbehaved in the three following years was 19·3 with a mean annual number of items of 35·3. These results show that the behaviour of many of the defectives improved. Parole was first granted in 1930. This, no doubt, was related to the marked fall in the number of those misbehaving (from 45 to 16) in 1931.

An investigation of the attempts to escape shows much the same results. Although many factors, such as amount of money, number of Staff, etc., are involved in individual escapes, one of the most important factors is that of contentment. For the year ending March 31, 1930, the percentage of attempts (whether successful or not) to the population of 333 was 18; for the year ending March 31, 1931 to the population of 321 it was 15·6, whereas to a mean annual population of 330 in the three succeeding years it was 6·2. This improvement might be due to the admission of a more settled type of patient. The only difference in the type of admissions in the last three years appears to be that they may be a little more troublesome than in the early years under review.

The above improvements coincide with the initiation of various administrative measures during the superintendency of Dr. R. F. Jarrett in 1930. In that year parole was first granted. From that time additional privileges were added up to March 1933, so that, at the present time, the following scheme is in force for patients of good behaviour:—

Period of good behaviour	Privilege	Parole
3 months	Work pass	When at work
6 months	Special block	Party parole outside estate with permits
9 months	" "	As above with individual parole on estate
12 months	Block managed by inhabitants	As for 9 months

There is thus a graded series of rewards for continuous good behaviour.

The work passes enable the patients to go to their work, to be at their work, and to return from their work without observation by the staff. They are not issued to patients who work as domestics in their blocks.

The blocks managed by the inhabitants consist of two blocks, one containing 16 patients, the other 37. A committee of patients, elected by the patients, is responsible for the proper management and cleanliness of, and good behaviour in, the block. A committee meeting is held weekly, the minute book being forwarded to me. The blocks are visited by the staff once in the morning for the issue of stores and in the evening for roll-call. During the remainder of the twenty-four hours they are not visited, except on irregular inspections by the senior officers. The system has been in force for a year, and has worked satisfactorily.

This grading of privileges is seen also in the furnishing. The blocks containing the twelve-month patients have curtains, easy chairs, table-glasses, fancy china, etc.; those containing the patients with less than six months' good behaviour have not these refinements.

The above scheme does not, of course, apply to special patients who need constant observation, such as idiots, low-grade imbeciles, and the epileptics or the physically helpless.

A corollary of this behaviour-grouping is a thorough investigation of acts of misbehaviour. Each individual act must be investigated in order to determine whether the patient was in the wrong, the origin of fights must be investigated so that the attacker is differentiated from the defender. Many witnesses may have to be seen. Only by adopting such a technique can the patients be made to understand that certain behaviour is invariably followed by certain results. If there is doubt as to the results, the patient will not control his emotional activities so satisfactorily.

At present, with a population of 363, although 32·5% are criminal cases, 73·3% show three months' good behaviour, 58% six months', and 62·7% were allowed parole outside the estate last year. With the exception of one patient breaking his parole, there was no misbehaviour or complaint of any kind with regard to the patients on the 2,190 occasions that parole was granted.

Investigations should also be made to compare the behaviour of the defective before admission with his behaviour after leaving the colony.

Of the patients in 29 unselected cases who had committed crimes of arson (2), sexual offences (10), theft (15), loitering (1), wandering (1), only two committed further crime during observation periods of from ten years and eight months to two years and two months after leaving the institution. The absence of thieving after leaving the institution might be due to improved conditions, but it is less likely that the absence of sexual offences and, possibly, arson could be due to such causes.

If the stay in a colony improves the defective's behaviour, then proof could be obtained from those patients who, on leaving the colony, return to the same surroundings as they were in before admission. Of 30 unselected cases who misbehaved before admission and who proceeded on licence to the address from which they had come, 26 have remained outside the colony for periods varying from ten years and eight months to one year and one month; four have been returned to the colony for various reasons.

By three methods of investigation, results are obtained in each which show that a stay in an institution improves the defective's behaviour.

Dr. Isabel Wilson said one often heard the remark that it was a waste to spend much money on defectives, but those who said that forgot that money so spent went largely to the relief of homes. Those who happened to visit homes and see mothers wrestling with the care of low-grade defectives, who were preventing the other children in the family from having what otherwise they might have, realized how the contribution to this work helped the home from which the defective child came.

She had also heard it said that in these institutions the children were not taught anything, but from her knowledge of them she was able to say that such a statement was untrue.

But she had wondered why these criticisms had been made at all. It might be that, as yet, high-grade defectives who might become fit for community care were not taught enough about the common facts of life; they might know a good deal about basket-making, but not much about health insurance and the "dole," and

what happened if a person committed a crime—to give some examples of the sort of thing which made these patients feel ignorant among their fellow-workers outside. In some institutions, too, there was a tendency to teach the children about institutions, and not about homes—with regard to cookery, laundry, etc.

Dr. Murdo Mackenzie said that as he had looked after only two persons suffering from mental defect in his life, the remarks he was about to make could not be said to be founded on experience. But it was clear to those who were concerned in their daily work with psychiatric problems in the sense of mental and nervous disorders, that if they wanted to be happy about their results they were wrong to take up psychiatry, that it was mental deficiency they ought to have dealt with. He had never heard such optimism as to results in the field of psychiatry.

There might be something in Dr. Noel Burke's objection to generalization, but in the private practice of psychiatry the neurologist saw patients when they were moderately affluent and said they had neurosis; psycho-analysts saw patients when they had lost some money and said they had psychoneurosis; psychiatrists saw patients when the precipitating factor in their illness had been financial distress, and they were then said to be suffering from psychoses.

He was much interested to hear Dr. Shrubsall say that at one time the patients under discussion were described as " natural fools," for he thought that, considering the number of natural fools he had met, the sooner the mental deficiency experts reverted to describing their clientèle as natural fools the sooner would they note an improvement in their financial outlook.

Dr. Noel Burke had said that simplification was undesirable; it might be undesirable in mental deficiency, but it was the one thing wanted in psychiatry: in the latter there were so many complexes that the ordinary simple person could not understand it.

In reference to mental deficiency, the first thing of importance was education. One speaker to-night seemed to have proved that those who passed through the special schools were better off than those who escaped being sent to them; they obtained better jobs and were more employable, and, presumably, better behaved. That might suggest that possibly too much money had been spent on mental defectives, and not sufficient on those who did not go to special schools. There was the question of the training of the parents, which was one way of dealing with the defective child. One expert had suggested that nearly always the children were better off mentally than their parents; if that was so, it was a dangerous method to educate parents who were grossly mentally defective to help them look after the less mentally defective offspring.

One speaker had referred to his dealings with a boy who had murdered his mother for sixpence. Dr. Fairfield had urged that one must regard these deficients with friendly feelings, and so bring about more beneficial results, but he (the speaker) thought that, even as friends, one would prefer to keep them at a certain distance.

On Dr. Rudolf's treatment and his results, he (Dr. Mackenzie) could make no comments, as psychiatrists did not get such results.

He would end by relating one experience with a mental defective, who came into the category of moral defect. He entered hospital from prison. He had stolen something at school and people said he was very badly done by. On leaving school he was engaged as a butcher's boy; he stole from his employer and was discharged. Exercising the humane spirit which was advocated, his friends got him another post, namely, as organist at a church, where he was also responsible for the money-bags, and the latter he rifled. This disgusted his church employers and they discharged him, and so from the church he proceeded to prison. He was attractive looking, a

skilled musician, and in some respects highly gifted. When he came to hospital the staff waxed strong with the friendly spirit and it was felt that everything possible should be done for him as a human being. He was at hospital voluntarily, and money was raised for the purpose of having him taught music and the speaker lent him five shillings. The next which was heard of him was from a small police court where he told them he was an inmate of a nerve hospital suffering from a nervous breakdown and asked consideration of the magistrate on that account. He went to prison again, and he (the speaker) had not heard of him since.

The association of special schools with mental deficiency was unfortunate, as these schools made people feel that something was happening to their children and the public were quick to associate the schools with mental deficiency.

Dr. W. A. Potts said he was able to corroborate Dr. Rudolf's experience, which was due to the fact that the mental defective was a different type from the psychotic. The latter was suffering from something which affected the whole mentality, but a certain number of defectives, while defective on many lines, sometimes showed exceptional ability in certain directions. He had known a mental defective who could act as church organist but was incapable of earning his living. He wanted to go in for telegraphy, but he had to leave that because he was unable to learn the Morse alphabet and code. He was very clever at metal work, but was unable to co-ordinate his life properly.

In Birmingham attention had been directed to the importance of environment, and when investigations were made for evidence for the Sterilization Committee, an effort was made to find out what was the effect of environment on mental defect. In Birmingham, the wards were arranged into an inner ring, a middle ring, and an outer ring. The inner ring wards were largely slum areas, the middle ring were medium grade, while the outer ring embraced more salubrious quarters. The death-rates accorded with that demarcation, the death-rate being highest in the inner ring, lower in the intermediate ring, and less in the outer ring than in either of the others. And it was found that the incidence of mental defect corresponded exactly with the death-rate.

An important fact was that, although that applied exactly in the case of the feeble-minded, it did not so closely apply to imbeciles and idiots; in the last-named it did not apply at all, there being the same proportion of idiots in the better situated areas as in the lowest quarters.

One speaker had said that in the future the real cause of mental defect might be found to be a combination of unfavourable heredity and environment. At present he (Dr. Potts) did not think the exact cause was determined and the remark just referred to might prove true.

Dr. Earl said that he agreed with Dr. Burke as to the danger of collecting various patients under one heading. The law defined mental defect as a state of arrested or incomplete development of mind, but the law did not say what the mind was, or what constituted a complete or unarrested mind, and where the law did not define there was no need for the medical man to rush in.

Several speakers had mentioned institutional treatment; this he considered was admirable. He had care of a hostel for high-grade boys, and he had to select boys for the institution. If the institutions were fulfilling their functions one would be able to say, "Here is a boy who has been ten years in an institution, and he is more likely to be of use than another boy who has not," but at present an institution boy was almost invariably refused. Boys who had been in institutions were unused

to freedom, and did not behave normally in the world, and it was pathetic that so many years had been spent on getting the results that one saw. Under comparative freedom, such as that described by Dr. Rudolf, there was marked improvement. It was important that the boys received individual attention and the correct psychiatric treatment. There was no reason why a boy of 14 with a mentality of 9 should not be as amenable to modern lines of approach as a high-grade defective. In the Rome Institution at New York a great deal of hostel treatment was carried out, and there was a marked improvement in the patients.

Sir Weldon Dalrymple-Champneys said that in the past he had had a certain amount of experience of mental deficiency work, and thought he was entitled to feel some gratification as the originator of this discussion, which was one of the most interesting that he had ever heard in the Society's buildings. Much of it had been to him both new and encouraging. As the Chairman had mentioned, he (Sir Weldon) had originally suggested the title, "Is the Treatment of Mental Deficiency worth while?" but he did not wish the meeting to think that he had suggested that title because he thought the treatment of mental deficiency was not worth while, but because a provocative title was most likely to stimulate a good discussion. The Council's alteration had, however, been fully justified by the event, since the experts had been just as much on their mettle as if the original title had been employed. His views before the meeting had not been so optimistic as they were after hearing the discussion. He had been in charge of special schools in Willesden for some years, and—perhaps as a result of what he saw there—his ideas of the prospects in mental deficiency work were rather gloomy. Indeed, he thought the situation in regard to this subject must have greatly changed in recent years, and it made one feel that human progress was a reality, however dark the horizon of world politics might appear. Such wonderful progress had been made in the treatment of mental deficiency that one's faith in human nature was inevitably strengthened.

Dr. Shrubsall (in reply) said he did not contend that the treatment of mental deficiency was curative, in the sense of restoration to normal; its object was the socialization of mental defectives, and in that connexion the real emphasis should be on the home and the individual. The home benefited tremendously by the measures which had been indicated in this discussion. The Mental Deficiency Act might well be compared with a filter at water-works, as he had said in his paper. Self-respect was a most important thing. The mental defective in the home who had been looked upon as the fool of the family, and had been kicked and cuffed about, but who, having been to a special school, had learned to repair boots and shoes, which his brother who went to the ordinary school could not do, received praise instead of blame, so that his "stock" rose enormously. There was a little weakness in some forms of institutional treatment. Inside institutions there could be, of necessity, relatively little opportunity of moral choice; things were done by rule, and there was but little gradation. If these children went out into the world they had to learn to face moral difficulties. There must be faced some gradual form of "temptation" to immunize or prepare defectives for temptation when they got out into the world. Whatever was done in that way must help them on towards the capacity to make moral choice, hence the greater the opportunities they enjoyed of going out, the better for them. Some years ago, when multiple stores exposed goods on the pavement for sale, juvenile crime went up, and many said that the Education Authorities ought to make representations in order to prevent these temptations. But the wiser Education Authorities said "No; children must be taught to be able

to resist temptation; they should be accustomed to live as they will have to live hereafter."

Special schools had training classes before the ordinary schools had them, and in those days the question of malingering had to be faced, as children who did not want to learn to read and write hoped they might go to a special school rather than to an ordinary school. He (Dr. Shrubsall) and his colleagues discovered a boy aged nearly 16 in a special school, who ran a business as a gas-fitter and who employed his father and another man as labourers or assistants while he remained in a special school to learn the trade. Now that greater emphasis was laid on the mental side, and socialization was one of the objectives, the term "mental defective" was regarded with some fear on the part of parents, and some said that the missionary efforts of the teachers had been thrown away. He thought it would be well if the words "mental defective" were dropped from the files of special schools.

Dr. Rees Thomas (in reply) said that in public mental hospitals there might be from 10 to 15% of mental defectives who were certified under the Lunacy Acts.

It had been said that defectives did not understand the importance of crime. The fact was that defectives had often never been taught or trained to respect others because they themselves had been neglected and treated as inferiors. In the home the defective had often been regarded as outside the circle of the normal children of the family.

The deterioration of the defective did not occur suddenly. Impulsiveness might be there, but the process was more commonly a gradual decline. He had had experience of patients who had committed serious crimes, had recovered, and had become again part of the social fabric. Though they had lived their lives to the best of their ability he had seen the onset and progress of the gradual deterioration. Crimes were often committed a long time after the patient had left any form of care and control. So it was not altogether true that defectives did not understand when they committed crimes, unless, of course, their intelligence was of a very low level. It was important to remember that if defective children were not passed into special classes or special schools they could not be notified to the Local Authorities at the school-leaving age, and so they never came into the care of the Mental Deficiency Authorities. Such cases would only come to notice when they had become the victims of neglect or privation or had committed a crime.

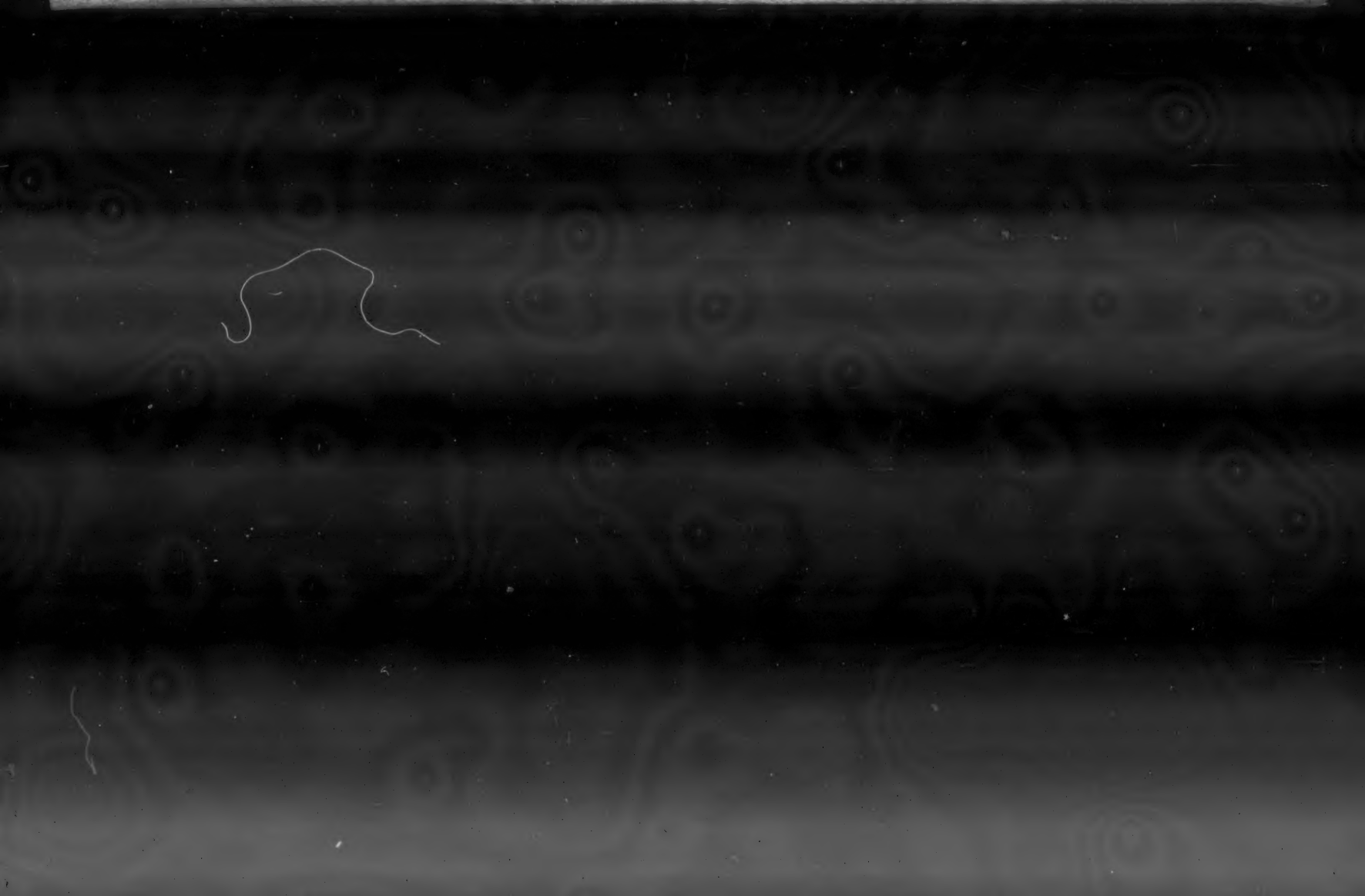
Dr. Burke had referred to the "mental hospital type"; he, the speaker, did not agree with that. He thought there should not be that type. The occupational treatment adopted in institutions for defectives was, with proper modification, designed to prevent the occurrence of that change. There was, too, a big difference between the psychotic and the moral defective from the point of view of treatment; the great advantage was that in the early stages the psychotic felt and feared his condition. So he would willingly come for treatment. That was not the case with the moral defective; he was proud of his achievements and regarded society as the real offender.

Dr. Burke (in reply) agreed with Dr. Fairfield, in her insistence on the importance of early ascertainment and treatment. A Jesuit had said, "Give me the child before he is 7, and you can do with him as you like afterwards." He (the speaker) looked forward to the day when defectives would be ascertained before they could be said to belong to the Education Authority, and so could be brought under the treatment appropriate to them, before they had been ruined by contact with the

less favourable aspects of the world, against which they had no inherent endowment of proper defences. Then institutions would be easier to manage and more socialized patients might be returned to the community.

Troublesome behaviour was usually due to faulty treatment and Dr. Rudolf's boys had all improved because of the handling they had received.

Dr. Isabel Wilson had made a criticism which was apparently deserved—that those in charge of mental defectives did not teach their patients, as definitely as they should, adaptation to some of the problems of the outer world. He (Dr. Burke) had thought that this was being done, but after Dr. Wilson's remarks, which made him doubtful, he would look again.



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